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On the Caecilian Species *Ichthyophis glutinosus* and *Ichthyophis monochrous*, with Description of Related Species

BY

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ABSTRACT: The Asiatic forms of the genus *Ichthyophis* are considered. The species generally recognized as *Ichthyophis glutinosus* and *Ichthyophis monochrous* were each found to consist of several species. The species described by Taylor, *Ichthyophis glandulosus* and *Ichthyophis weberi* synonymized by Inger are resurrected and recognized, and the following species synonymized by Boulenger and others are revived: *Ichthyophis tricolor* Annandale, *I. beddomei* Peters. *Ichthyophis monochrous* Bleeker is recognized and is believed to be confined to the island of Borneo. *I. glutinosus* Linnaeus is likewise recognized as an Asiatic species.

Larvae from a number of places were examined. Certain of these seemingly belong to species whose adults have not been seen and are probably undescribed. No attempt has been made to utilize larvae as types of species.

The following forms are described as new species: *Ichthyophis dulitensis*, *I. larutensis*, *I. paucidentulus*, *I. singaporenensis*, *I. peninsularis*, *I. subterrestris*, *I. bombayensis*, *I. mindanaoensis*, *I. javanicus*, *I. malabarensis*, *I. youngorum*, *I. sikkimensis*, *I. sumatranaus*, *I. acuminatus*, *I. nigroflavus*, *I. paucisulcus*, *I. supachaii*, *I. kohtaoensis*.

A number of specific characters have been considered that have been heretofore largely neglected. These are the character and distribution of the scales, the continuity or discontinuity of the folds and grooves around the body, the presence or absence of a row of splenial teeth (second mandibular series), the number, relative size and characteristics of the other dental series, and the length and characteristics of the tail.

In the larvae the lateral line system (neuromast) varies much and seems to reflect habits of the young. Certain of the larvae have only a single gill slit; others have two well-developed slits.

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INTRODUCTION

In the work of Seba¹ (*Thesaurus*, vol. 2, 1735) a species of caecilian was described briefly under the name *Serpens caecilia ceylonica*, Ceylon being the type locality of the species. Here it was presumably considered as a snake.

Nineteen years later, in 1754, Linnaeus listed two caecilians in a work, "Museum S. R. M. Adolphi Friderici." . . . These were *Caecilia tentaculata* from South America and *Caecilia glutinosus*, a new species described with "Habitat in Indiis."

The description of *glutinosa*, published both in Latin and Swedish,

1. Seba, A. *Locupletissimi naturalium thesauri accurata descriptio et iconibus artificiosissimus expressio, per universam physices historiam*. Vols. 1-4, 1734-1763, 449 pts. Amsterdam. (Vol. 2 published in 1735.) A copy of this description, vol. 2, p. 26, was published in Taylor, Univ. Kansas Sci. Bulletin, vol. 38, pt. 2, no. 13, Mar. 20, 1958.

though brief, is scarcely sufficient to distinguish an Indian or Asiatic species. The description in Latin reads as follows:

Caecilia glutinosa

"*glutinosa* Caecilia rugis transversalibus 340, caudalibus 10.

"*Caput* parvum, laeve. *Narium* foramina in antica parte capitinis. *Cirrhos* nullos observare potui. *Oculi* minutissimi, membrana abducti. *Dentes* utriusque maxillae minimi, serie dupli.

"*Truncus* cylindricus, versus posteriora paulo crassior: *Rugis* minutissimis, vix visum subemtibus, a tergo retrorsum nonnihil flexis at futuram abdominis, coquentes angulo acuto. *Rugae* majuscule circiter 350.

"*Cauda* brevissima acutiuscula, anus sub & juxta apicem caudae.

"*Color* fuscus: linea utrinque laterali albida, latiuscula.

"*Longitudo* pedem superat. Crassities digitii minimi.

"*Glutine* vedetur viva esse obducta uti petromyzon."

Further data from the type specimen is necessary before this species can be placed properly.

Anderson (1899), Catalogue of Linnean type specimens of Snakes, Bihang Till K. Svenska Vet.-Akad Handlingar, Band 24; Afd. 4, No. 6, page 6, states that 355 folds are present and that the length is 400 mm.

The description is scarcely adequate for distinguishing a species of Indian caecilian. Linnaeus states that he has not observed a tentacle on the head; however one must presume that a tentacle is present. That it is not a larva is presumed by the fact that neither gill slits (spiracles) nor a tail fin are mentioned. The species under the same name is listed by Linnaeus in the 10th edition of the *Systema Naturae* (p. 229).

Certain subsequent authors have used other names presumably in reference to the Linnaean species. Thus Latreille lists *Coecilia viscosa* as a substitute name² and Cuvier uses the name *?Coecilia bivittata* in the *Regne Animal* (1817, p. 100) while on another page (tome 2, p. 87) the Linnaean name is used.³

In 1826 Fitzinger⁴ proposed the taxon *Nuda* for his fourth tribe (*Tribus*) of the Reptilian, Order (*Ordo*) Menopnoa. The first and only family designated in this was *Coecilionidea*. He included in it the genera *Caecilia* Linnaeus [= *Coecilia* Cuvier] (using the spelling given by Cuvier rather than that given by Linnaeus), and a new genus *Ichthyophis*. Of these he states:

². Latreille, P. A. In Sonini and Latreille, *Histoire naturelle des Reptiles*. Vols. 1-4, 1802, p. 236.

³. *Le règne animal distribué d'après son organisation, pour servir de base à l'Histoire Naturelle des Animaux et d'introduction à l'Anatomie comparée*, vols. 1-4, 1817, Paris.

⁴. *Neue Classification der Reptilien nach ihren natürlichen verwandschaften nebst einer verwandschafts—tafel und linem verzeichnisse der Reptilien—Sammung des K. K. zoologischen Museum's zu Wien*. 1826, pp. 1-66, 1 table. F. G. Heubner, Wien.

Isolirt steht diese Familie in der Zunft der Nuden, das Bindungsglied der Monopnoen mit der Dipnoen bildend. Beim Ueberblicke der Arten der Cuvier'schen Gattung *Coccilia* zeigt sich sogleich in der Totalform eine Hauptverschiedenheit, welche zur Trennung meiner Gattung *Ichthyophis* Veranlassung gegeben hat. Linne's *Caecilia glutinosa* und eine Art aus Java haben einen deutlich plattgedrückten Körper mit zugespitztem Ende, welcher den übrigen Coecilen durehans fehlt, und hierauf ist der generische Unterschied gegründet. *Coecilia* bildet den schönsten Uebergang zu *Leposternon* aus der Zunft der Squamaten, und durch *Ichthyophis* zu *Amphiuma*, *Siren* und *Pseudobranchus*, aus der Zunft der Immunabilien in der Ordnung der Dipnoen."

Subsequent to the proposal of the genus *Ichthyophis*, Fitzinger proposed the name *Ichthyophis Hasseltii* for a species based on a specimen in the Vienna Museum from Java. One is forced to conclude that the *Ichthyophis Hasseltii* of Fitzinger is a *nomen nudum* since he offers only the following meager data on the specimen:

Page 36: *Caecilia glutinosa* and a new species from Java have a distinct "plattgedrückten" body with a "zugespitztem Ende."

Page 63. Fitzinger lists species present in the Vienna Museum: *Coecilia annulata* and *C. lumbricoides* respectively from Brasil, and an unknown locality; and a third species, *Ichthyophis Hasseltii*, from Asia, Island of Java.

These data seemingly cannot distinguish *hasseltii* from certain other species of *Ichthyophis* now known.

The following year Van Hasselt, in *Isis*, 1827, p. 565, under the name *Coccilia hypocyanea* described a species from Java in the Vienna Museum, presumably the same specimen that served as the basis for the name *I. hasseltii*. The description follows:

"Capite indistincto, depresso laevissimo, tentaculato, tentaculo ad marginem maxillarum utrinque antorbitali minuto, oculis parvis hebetibus, cauda brevissima, trunco fusiformi, capite paulo latiori, rugis 320 circiter sutura abdominali oblique interruptis, aretissime annulato. Supra ex olivaceo obscura, subtus chalybea linea laterali flavopunctata;"

The following authors have used this name and figured the form: Müller 1835, p. 391, pl. 8, figs. 12-14. Schlegel, 1832-1844, p. 119, pl. 39, fig. 1. Wagler, 1828, p. 743 reports this species as *Epicrium Hasseltii*. "Corpore supra obscure olivaceo, subtus chalybeo-caeruleo, lateribus lineis duabus maculosis flavo ochraceis picto; trunci rugis circiter 320. Habitat in Java insula locis paludosis Javanis Octur-doeël dictum."

The original description of *Ichthyophis monochrous* was published by Bleeker (Nat. Tydschr. Nederl. Indië, vol. 16, 1858) as *Epicrium monochroum*, in section 7 of the generalized title—"Bestuursvergadering gehouden ten huize van den Heer De Bruijn Kips den 11 Maart 1858."

The section 7 begins: "De Heer Bleeker deelt made, dat hijdezer

dagen weder eene verzameling reptilien en visschen van Sinkawang (westkust van Borneo) ontvangen heeft.

“Deze verzameling is, evenals vroegere van Sinkawang, aangeboden door het lid der Vereeniging, den heer J. H.A.B. Sonnemann Rebentisch.

“De reptilien bestaan uit de volgende soorten.” . . . [On page 188 the following description appears]:

“No. 15 *Epicrium monochroum* Blkr.

“De heer Bleeker vertoont laatstgenoemde soort in een voorwerp van 232 millimeters lengte. Het is van eene violetbruine kleur over het geheele lichaam en slechts iets lichter gekleurd aan de ondervlakte van den kop, terwijl de anus door eene witachtiggele vlek omringd is. De overlangsche gele band van *Epicrium glutinosum* Wagl. ontbreekt volkomen. Ook zijn er niet, zooals de heer A. Duméril van *Epicrium glutinosum* opgeeft, 325 volkomene cirkelvormige huidplooijen maar slechts 246 plooijen in het geheel, welke alle aan de buikvlakte een’ stompen naar achteren gerigten hoek vormen. De hoogte des lichaams gaat ovgeveer 25 malen in zijne lengte. Het kuiltje onder de oogen bestaat doch is zeer oppervlakkig, heeft weinig verhevene randed en ligt nabij de bovenlip een weinig voor het oog. De schubjes zijn uiterst klein. Het lichaam is aanmerkelijk dikker in het midden dan aan het kop-en staarteinde. De heer Bleeker beschouwt het voorwerp op grond der genoemde kenmerken als eene eigene soort, welke vrij aanmerkelijk van *Epicrium glutinosum* verschilt.”

Peters,⁵ in 1879 described a species from India under the name *Ichthyophis beddomii* while a second Indian form was named *Ichthyophis glutinosus tricolor* by Annandale in 1909.⁶

Boulenger in the “Catalogue of the Batrachia Gradientia s Caudata and Batrachia Apoda in the collection of the British Museum” (1882) recognizes only two species in the genus *Ichthyophis* and Boulenger has been largely followed by all subsequent writers dealing with the genus.

Thus the genus *Ichthyophis* for more than half a century was generally regarded as comprising only two species of caecilians. One, the species *Ichthyophis glutinosus*, described by Linnaeus in 1758 whose range came to be defined as extending from the East Indies through southeastern Asia to India. The second species, *Ichthyophis monochrous* described by Bleeker in 1858 was sup-

5. Mon. Akad. Berlin 1879, p. 931.

6. Rec. Indian Mus., vol. 3, 1909, p. 286.

posed to range from Borneo through Java, Sumatra, Malaya, Siam, Ceylon, and India, to Sikkim.

In 1920 I obtained a specimen of a caecilian discovered by C. M. Weber⁷ on Palawan Island, Philippine Islands. This I described as a new species, *Ichthyophis weberi* differing, among other characters, from *I. monochrous* in lacking the inner row of mandibular teeth (splenials) and in having some 78 more circular folds about the body⁸ characters which an experienced taxonomist probably would accept as being worthy of designating a different species.

In 1923 I discovered still another form of caecilian on Basilan Island, Philippine Islands, which was named *Ichthyophis glandulosus*.⁹

The published ranges of these two species, *I. glutinosus* and *monochrous*, were truly surprising. It became apparent that a remarkable happening had taken place in the southeastern part of the range of the genus in the Philippines and Borneo where no less than three species were present; while no change was recognized in the two species which purported to extend from Borneo to Sikkim in the Himalayas, and to Ceylon, a distance of several thousand miles.

It is almost an axiomatic rule that genera of low vagility tend, as they spread, to speciate to a greater degree than those of greater vagility. Burrowing genera of reptiles and amphibians are perhaps the least vagile of all the vertebrates. But here were two recognized species of burrowing caecilians whose ranges were enormous and in which, presumably, there had been little species formation, thus contradicting the generally accepted belief. This problem definitely merited investigation, to account, in some way, for this lack of plasticity in the genus, or to prove that such ranges did not exist.

On the basis of experience in the Philippines, I concluded that most evidence pointed to the fact that previous authors had in some manner confused species (since extraordinary variation in the number of the primary and secondary folds had been recorded in the literature), and that we were dealing with species—perhaps

7. Later killed by natives on the nearby island of Balabac.

8. This form has recently been placed by Dr. Inger in the synonymy of *Ichthyophis monochrous*. This should be disregarded, largely because the author has a different concept of species (his own statement), because of his inexperience with Amphibia, and perhaps his lack of knowledge that much caecilian material in museums is misidentified.

9. This form also was relegated to the synonymy of *I. monochrous* by the same author as the preceding. He comments that the lateral fold is not glandular, despite the fact that on it many hundreds of glands are present. He states, "Ichthyophis glandulosus Taylor is probably conspecific with *monochrous* Bleeker. I am unable to find distinguishing characters" . . . this statement I believe, is made by Inger without his having seen a specimen of either *monochrous* or *glandulosus*. His action I believe should be disregarded for the reasons set forth in the preceding footnote.

even generic complexes in the nominal *Ichthyophis monochrous* and *Ichthyophis glutinosus*.

In 1958 I discovered certain undescribed species of the genus in Thailand, definitely not to be associated with either *monochrous* or *glutinosus*. On my return journey from Thailand to America I visited museums in Ceylon, Germany, France, and England and examined the specimens classified under the two above names. I found that my tentative conclusion was confirmed—that several undescribed species were masquerading in museums under the names *Ichthyophis monochrous* and *I. glutinosus*.

Through the kindness of the staffs of the various museums I was permitted to record data or borrow specimens for later study. Further material was made available by certain American museums. There follows here a review of most of the available material with the results of my study.

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TAXONOMIC CONSIDERATION

Ichthyophis weberi Taylor

Ichthyophis weberi Taylor, Philippine Journ. Sci., vol. 16, no. 3, March 1920, pp. 227-228 (type locality, Malatgan River, Palawan, P. I., C. M. Weber coll.); Dept. Agri. Nat. Resour. Bureau Sci. Manila, Publ. 15, December 15, 1921, pp. 26-27 (reprint of preceding type description).

Ichthyophis monochrous van Kampen (part.), The Amphibia of the Indo-Australian Archipelago. Leiden, 1923, pp. 3-4, 282 (synonymy questioned); Inger (part.) Fieldiana: Zoology, vol. 33, no. 4, July 23, 1954, pp. 207, 209 (unquestioned synonymy).

Type: Formerly, No. B-1, Bureau of Science collection; collected at Malatgan River, Palawan, January 28, 1909, by C. M. Weber.

Description of type: "Two rows of teeth in upper jaw, the series forming oval arches, parallel to each other, the inner row extending much farther back than the outer but not widening; lower jaw with a single row of teeth, with no evidence of a second row; head oval, eyes distinct, the distance between them very slightly less than width of head between eyes; distance between eyes a little greater than length of snout; tentacle withdrawn, the groove rather moon-shaped, situated anterior to eye near the edge of upper jaw;

body surrounded by three hundred twenty-four circular folds meeting on belly in an angle, except those on posterior part of body, which run straight across without an angle; the first three or four folds on anterior part of body fail to meet; a more or less distinct groove from tip of lower jaw to some distance in front of anus along the median ventral line of body.

Color in alcohol: "Above yellowish brown, somewhat darker on median part of body; below lighter yellowish brown. Under a microscope the color appears as minute rounded yellowish dots surrounded by a network of brown. A white spot on tip of lower jaw."

Measurements of Ichthyophis weberi Taylor

	mm.
Total length	250.
Tail	2.5
Width of head at eyes.....	7.5
Length of snout	5.
Eye to nostril	3.5
Eye to tentacle	1.5

Remarks: To the best of my knowledge no specimen other than the type has ever been taken of this species. I know of no scientific expeditions that have been undertaken in the island of Palawan in recent years.

I visited the Bureau of Science in Manila in September 1957 with the intention of re-examining the type specimen of *Ichthyophis weberi*, only to learn that the type together with all the extensive herpetological collections of the Bureau of Science, largely brought together by me, had been destroyed during the second World War.

*Ichthyophis larutensis** sp. nov.

Ichthyophis monochrous Flower** Proc. Zool. Soc. London, 1899, (Nov. 14), p. 916 (not of Bleeker).

Type: British Museum Natural History, No. 98.9.22.208, Larut Hills (near Maxwell's Bungalow), Perak, Malaya, elevation 3,380 ft. Stanley Smyth Flower collector. (A second specimen mentioned, see footnote.)

* Larut (Mts.) + ensis (Latin) = place, locality, country.

** Flower comments on the form: "In April 1898 on different days I obtained two specimens from under a stack of firewood near 'Maxwell's Bungalow' in the Larut Hills, Perak, elevation 3380 feet.

"1st. Number of circular folds about 313; length 208 mm.

"2nd. Number of circular folds about 309; length 167 mm.

"As in *I. glutinosus*, some of the circular folds either bifurcate or converge into each other; therefore the number, in counting the same individual at different parts of its circumference, varies.

"Colour (in life): Uniform purplish black. Tentacles white. Anal region and tip of tail pale pinkish. The eye appears as an inconspicuous black speck (but turns whitish in spirits)."



FIG. 1. *Ichthyophis larutensis* sp. nov. Type B. M. N. H. No. 98.9.22.208, Larut Hills, Perak, Malaya, elev. 3380 ft. Actual length, 169 mm.

Diagnosis: A slender species, the body width in length, 30.7 times; tail length in body length, 48.3 times; transverse folds do not cross back in anterior three fourths of the body; approximately 304 transverse folds ("about 309" counted by Flower *loc. cit.*); folds on tail, 7; no splenial teeth present; tentacle nearer to eye than to nostril. Vertebrae, 107.

Description of type: Head slender, oval, the width at first nuchal groove, 5.1 mm.; the head length, 11 mm.; eyes distinct, the pupil white, surrounded by a narrow black iris; this in turn surrounded by a narrow cream ring; distance between eyes, measured on the curve, 3.8 mm., a little broader than length of snout (3.5 mm.); tentacle close to lip, nearer to eye (1 mm.) than to nostril (1.8 mm.).

First transverse nuchal groove crosses throat, runs upward and somewhat posteriorly, but fails to cross the head completely; the second groove crosses throat and goes up on side of neck nearly to dorsal level of neck; the third groove is distinct ventrally only and is rather widely separated from the second, forming a median angle below; primary and secondary grooves and folds about 304; they do not cross the middle line of the back except on the posterior fifth of the body; medially they fail to cross venter completely on anterior part of body; eight folds on tail counting from front of vent; tip of tail rather sharply pointed; a slight longitudinal groove on back part of chin connecting with the second groove.

Scales are absent, or minute and scattered in the anterior third of the body; posteriorly they are larger but consist usually of a single overlapping row in each fold.

Teeth: maxillary-premaxillary, 21-20, those on the premaxillae largest; vomeropalatine, 19-19; mandibular, 19-19; splenial, 0-0; tongue well developed covering entire area between maxillary-premaxillary series, not suggesting a recent transformation from the larval state; vertebrae present, 107.

Color in life (fide Flower): "Uniform purplish black, tentacles white; anal region and tip of tail pinkish;" at present the general color is dark brown; a cream-white spot on tentacular area and one about nostril; the grooves on throat are cream; lips lighter than head; the tip of tail and anal region cream.

Measurements in mm.: Total length, 169 (*fide* Flower, 167); tail, 3.5; body width, 5.5; width of head, 5.1; length of head, 11.

Remarks: The failure of the transverse folds and grooves to cross the back except in the posterior fourth is a significant character.

The light marks on the throat, the character of the third groove, the absence of the splenial teeth, and the pink spots at vent and tail-tip clearly delineate this form.

Two larval species of caecilians obtained in Perak are treated here. I am convinced that neither are the young of *Ichthyophis larutensis*.

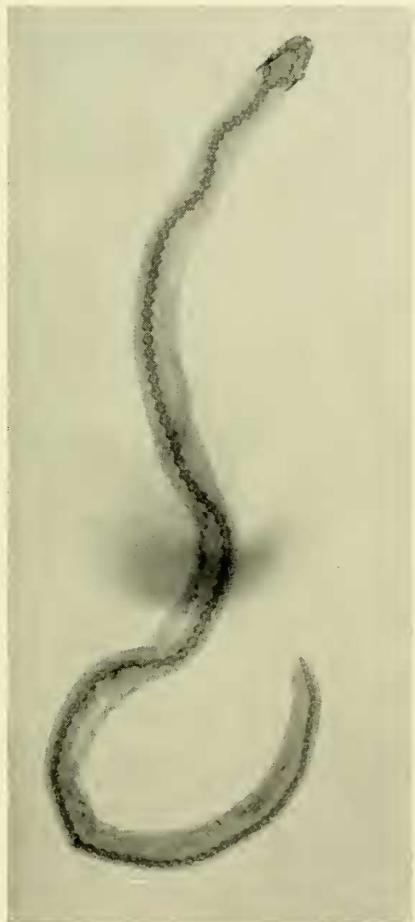


FIG. 2. *Ichthyophis larutensis* sp. nov. Type. Radiograph showing 107 vertebrae

Ichthyophis sp. (1)

A series of fifteen larval specimens taken "near Yum River, headwaters Plus River, East Perak, Malaya, 2000 ft." and bearing the British Museum numbers 1935.5.21.51 to 1935.5.21.65, cannot be

placed definitely in a recognized species. In fact it would appear that two forms are represented in the material, and neither of them is the young of the species described here as *larutensis*.

The specimens were all taken in March 1923. They resolve themselves on the basis of length measurements into possibly three (presumably age) groups as indicated in the following table. These groups are not clearly limited, a fact which suggests that the reproduction period during a year is a rather extended one.

The table includes data on a second larval form (B. M. 1934 .5.21.50) and the type of *Ichthyophis larutensis*.

Data on two larval forms of Ichthyophis, and I. larutensis sp. nov.

NUMBER	Total length	Width	Width in length	Transverse folds	Max-premaxillary teeth	Vomeropalatine teeth	Mandibular teeth	Splenial teeth
1934.5.21.65	56	.....	.....	.....	.....	.....	.....	.....
64	62	.....	.....	.....	.....	.....	.....	.....
63	65	.....	.....	.....	.....	.....	.....	.....
64	65	.....	.....	.....	.....	.....	.....	.....
62	70	.....	.....	.....	.....	.....	.....	.....
1934.5.21.60	98	4.8	20	244	.....	.....	.....	.....
59	103	5	20.5	255	12-14	15-16	13-13	4-4
53	113	5.7	20	247	13-14	15-15	13-13	4-4
55	115	6	19	240	13-14	17-17	13-14	4-4
58	122	6	21	266	15-14	15-17	15-16	4-5
1934.5.21.56	132	7	19	249	13-13	18-18	16-15	5-5
54	137	7.3	18.7	257	15-15	21-21	17-16	5-5
52	140	7.2	20	261	14-14	18-18	15-15	5-5
57	140	7.1	20	268	15-14	18-18	18-18	5-5
51	141	7.2	20	265	13-14	17-18	14-15	5-5
1934.5.21.50*	184	8	23	348	13-14	18-18	20-20	7-7
98.9.22.208**	169	5.5	30	304	21-21	20-19	20-20	0-0

* Second larva.

** Type of *larutensis*.

The folds and the teeth on the youngest specimens cannot be counted. The eyes are indicated by rounded milky-colored areas, through which the eyeball is rarely visible. The tentacular opening is indicated either by a shallow pit or an opening (in older specimens) in the anterior part of eye-spot. The tail fin begins on the

dorsal part of the body about one or two millimeters in advance of the vent and continues around the end of the tail then forward to the back end of vent. The nostrils are terminal and not visible directly from above.

The gill opening is single with short free flaps preceding and following it; the transverse folds meet in the median ventral line at a sharp angle throughout most of the body except the part in front of the vent where they are almost straight across the venter. Six or seven folds are on the tail (counting from the front of the vent). The variation in the number of body folds in the specimens counted vary from 240 to 268. It is believed that much of this variation is sexual, females having the higher counts in at least some species.

Ichthyophis sp. (2)

A single specimen, B. M. No. 1934.5.21.50, taken in the locality "near Yum River, headwaters of Plus River, East Perak, 2000 ft." Malaya, differs from the preceding series in such a way as to suggest that it represents a different species.

The chief apparent differences from them are: the color is dark lavender to plumbeous instead of brownish; ten folds on tail (from front of vent) a somewhat larger series of splenial teeth; an increase of 80 transverse folds above the highest in the other lot. (See table for further data.)

That neither of these larvae is the young of *Ichthyophis larutensis* sp. nov. herein described, may be deduced from the presence of splenial teeth in the two types of larvae. These are absent in *larutensis* which is a slenderer form, transforming at a distinctly smaller size than the preceding larvae.

Ichthyophis paucidentulus sp. nov.

Type: U. S. N. M. No. 70671. Kapahiang, Sumatra; H. C. Kellers, collector.

Diagnosis: A presumed medium-small species having a barely discernible light streak on the side of body beginning at mouth angle, discontinuous in numerous places; no trace of splenial teeth, or of a ridge on inner side of jaw; eye moderately distinct through a gray-white spot in the eye-area (in preservative); tentacular opening lunate, relatively large, the tentacle conical, closer to eye than to nostril; the accessory cusp is clearly visible on the front teeth of maxillary and mandible; transverse folds, 393, 7 on tail; vertebrae, 122.

Description of type: A medium-small, slender specimen, the width in length, 34.5 times; head short, oval, the eyes dimly visible through a gray-white circular mark; head width at first nuchal fold, 8 mm.; length of head, 11.5; distance between eyes (6 mm. on curve) greater than snout length (4.9 mm.); eye to nostril, 3.2 mm.; tentacle conical, the tentacular opening lunate, above rather than behind tentacle, closer to eye (1.4 mm.) than to nostril (3 mm.); distance from tip of snout to first nuchal groove, 10 mm.; to second, 13; to third, 17.5; first nuchal groove distinct on throat, not crossing top of head; second visible below and on sides of neck; third indicated laterally but barely traceable across neck.

Primary and secondary folds, 393, counted on dorsum (fewer, 380 counted ventrolaterally); only a few anterior folds fail to meet; other folds on venter meet at an angle, directed backwards; each fold crosses the dorsum in a sinuous line and forms a convexity directed forward on median line, its anterior position on dorsum often from four to seven millimeters in advance of the ventral angle; posteriorly a few folds cross the body and venter almost directly. The grooves do not cross venter except posteriorly, in front of vent; four folds interrupted by the vent; no glandules * discernible on sides of vent; tip of tail somewhat flattened on top, not or scarcely compressed laterally.

Very small scales can be found in folds near the anterior part of body, absent or scarce on the ventral region anteriorly; more posteriorly the scales are larger and encircle body, about three imbricating rows in each fold.

Teeth: maxillary-premaxillary teeth, 25-27; vomeropalatine, 29-30; mandibular, 23-24; no trace of splenial teeth nor of the inner ridge or elevation that supports the splenials; most of the teeth have an anterior accessory cusp well developed, the teeth hooked; mandibular teeth larger than the maxillary-premaxillary series, and these in turn distinctly larger than the vomeropalatines; tongue large and rather thick, occupying all the space between the side of jaws; choanae elongate, somewhat angulate on inner border, separated by a distance slightly greater than twice the transverse diameter of one.

Color in preservative: Plumbeous on dorsum and sides; ventrally the shade is somewhat lighter; an indistinct, narrow, broken lateral line of dull cream from angle of mouth to near level of front of vent; a cream spot surrounds vent, widened at front end; tip of tail with

* These small glandules may be present only in males.

a small cream spot; a gray-white spot surrounding and covering eye; light whitish cream spots about tentacle and nostril.

Measurements in mm.: Total length, 294; tail, 6; head width, 8; head length, 11.5; estimated body width, 8.5; width in length, 34.5 times; tail length in total length, 49 times.

Remarks: This species on the basis of the increased number of vertebrae, and the lateral stripe, might seem to be closely allied to *Ichthyophis glutinosus*. This is highly improbable since the entire series of the splenial teeth is absent, and the jaw modified so that the usual inner ridge that bears the splenials is likewise absent. It probably is most closely related to *I. nigroflavus* sp. nov.

The secondary cusp on the teeth is more or less indicated in many species. In this form the size of the teeth makes the cusps more evident. The number of the maxillary-premaxillary and vomero-palatine teeth is, I believe, exceeded only in the largest known species, *Ichthyophis nigroflavus* sp. nov. and *I. malabaricus* sp. nov. On the other hand it would appear that the mandibular teeth are somewhat reduced in number.

The name *paucidentulus* is derived from Latin *paucus*, few; *dentalus*, toothed, in reference to the fact that there are only three instead of four sets of teeth.

Ichthyophis monochrous (Bleeker)

Epicrium monochroum Bleeker, Nat. Tijdschr. Ned. Ind., vol. 16, 1858, p. 188 (type locality Sinkawang west Borneo); Günther, The Reptiles of British India, 1864, p. 443 (part.) (refers a specimen from Singapore to this species, specimen having 226 circular folds); Proc. Zool. Soc. London, 1872, p. 591 (listing only).

Ichthyophis monochrous Peters, Monats. Akad. Berlin, 1879, p. 932 (part.); Boulenger, Catalogue of the Batrachia Gradientia s. Caudata and Batrachia Apoda in the collection of the British Museum, p. 91, pl. 4, fig. 1 (part.); Boettger, Ber. Senckenberg. Nat. Ges., 1887, p. 50; Boulenger, The Fauna of British India, including Ceylon and Burma. Reptilia and Batrachia, 1890, 517 (part.) (! Java, Borneo, Singapore, Sikhim and Western Ghats of India, Malabar, Waghei Surat, India); Proc. Zool. Soc. London, 1895, pp. 403-404 (part.); ? de Elcra, Catalogo Sistemático de toda la Fauna de Filipinas. 1895, p. 453; van Kampen, Amphibien des Indischen Archipels. Zoologische Ergebnisse einer Reise in Niederländisch Ost-Indien, herausgegeben von Dr. Max Weber, 1907, p. 415 (part.); Nieden, Das Tierreich. Lief. 37 1913 Gymnophiona, Berlin, p. 7 (part.); Bourret Les Batraciens de l'Indochine (? date), pp. 138-139, fig. 15 (part.).

Type: British Museum Natural History No. 63.12.4.5 Sinkawang, west Borneo.

Diagnosis: Vertebrae, 108; costal folds, approximately 247; length in width about 22-23 times; splenial teeth reduced, 4-4; four to five scalarows in each fold, at least in posterior half of body; four anterior folds fail to meet (ventrally); transverse folds cross the body

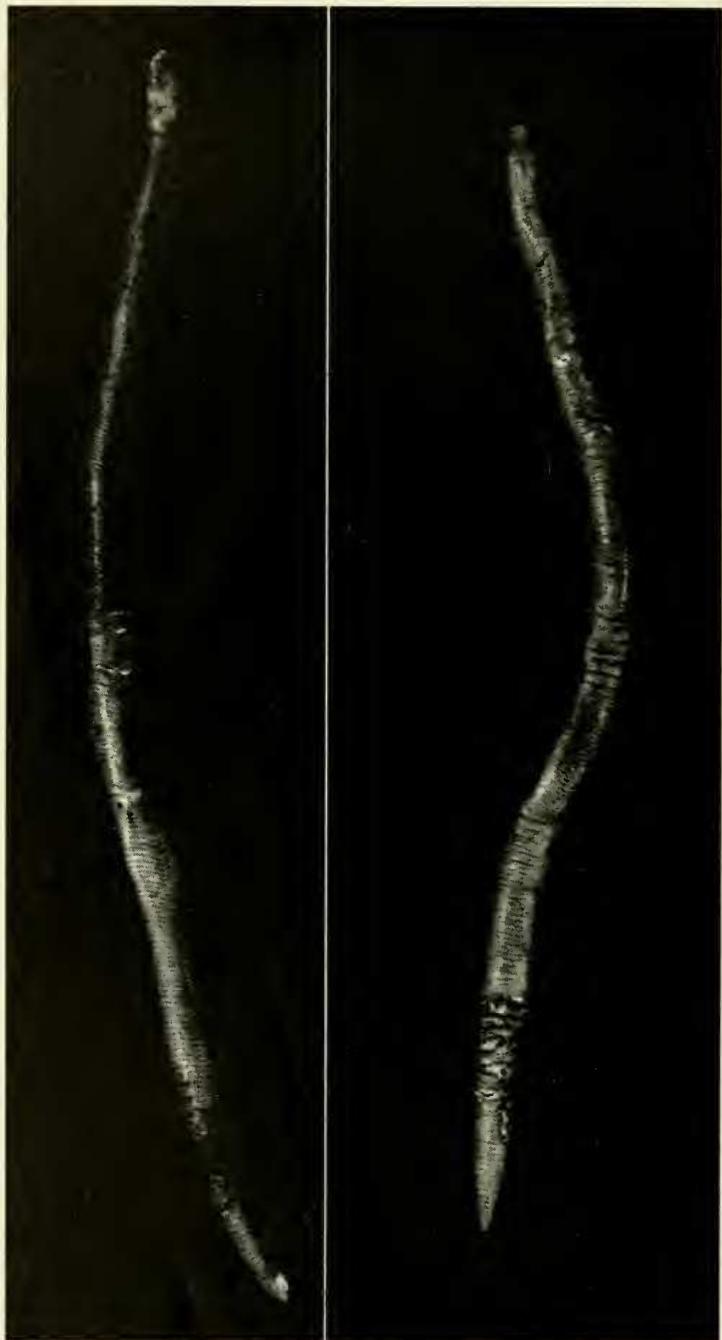


FIG. 3. *Ichthyophis monochrous* (Bleeker). Type. B. M. N. H. No. 63, 12,4,5. Sinkawang, west Borneo. Left figure, dorsal view; right figure, ventral view. Actual length of both figures, 232 mm.

forming a strongly marked angle on venter; a narrow cream-colored ring about eye, and a cream spot on vent; tail short, 3.8 mm., with six folds.

Redescription of type: A moderately slender species, the length 232 mm.; width about 10 mm.; the width in length, approximately

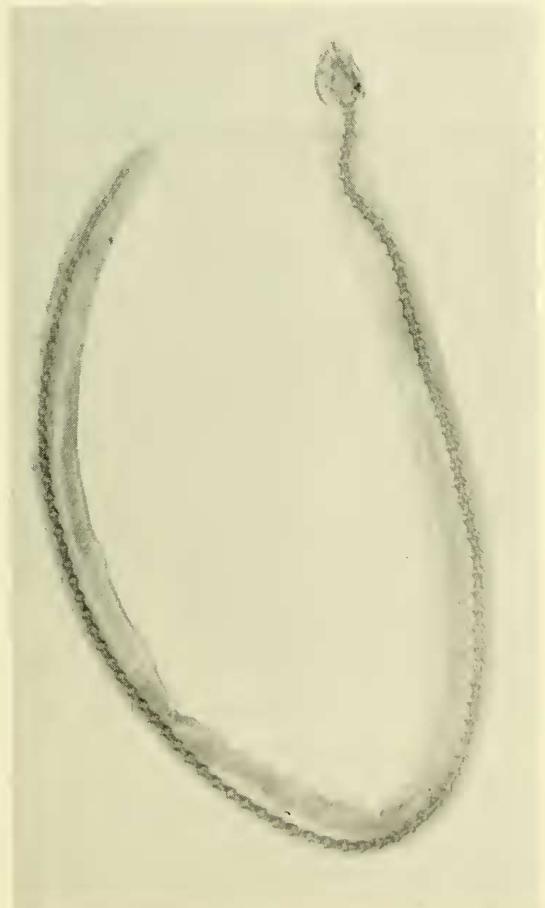


FIG. 4. *Ichthyophis monochrous* (Bleeker) Type. Radiograph showing 108 vertebrae

23 times; head oval in outline, the curved width between eyes, 6 mm.; width of head, 7 mm.; length of head, 9 mm.; snout length in front of eyes, 4.2 mm.; eye visible, its diameter .4 mm.; tentacle conical, situated near lip, closer to eye (1 mm.), than to nostril (2.5 mm.), the tentacular opening lunate; nostril to lip, 1.4 mm.; eye to lip, 1.15 mm.; length of head from first groove, 8.6 mm.; from

second groove to snout tip, 11.6 mm.; from third groove to snout tip, 14.8 mm. (measured on side); the first nuchal groove is strongly distinct on the throat, dim above; second groove strong on throat but not visible dorsally; third groove visible laterally, crossing above neck as a typical costal groove, not completely crossing throat below. This is preceded on dorsal surface by a short somewhat angular fold that terminates on the dorsal surface; the first four transverse folds (following the third nuchal groove) do not meet on venter; subsequent folds cross dorsum and sides in a sinuous line, then bend backwards and meet at an angle on venter, at a point four or more millimeters farther posterior than on dorsum. The primaries and secondaries (perhaps tertiaries)* cannot be ordinarily distinguished from each other.

There is a small but distinct tail bearing six transverse folds posterior to anterior edge of vent, its length about 3.8 mm.; an area about vent flattened; tail rounded above and somewhat compressed laterally, terminally pointed; no trace of elevated lateral longitudinal folds on body.

Skin strongly glandular throughout surface of body, and because of the folding most of the larger glands lie recumbent in the skin, very many having a length of more than one millimeter; each transverse fold overlaps somewhat the deeper following fold; concealed scales are present throughout surface of body, each fold covering from one to five rows of transversely overlapping scales which encircle the body; the preceding several rows of scales, though separated by tissue, actually overlap the anterior scale series of the following fold; scalarows of each fold imbricated, the anterior overlapping the posterior.

The largest scales measure 1.8 mm. in greatest diameter. The number of rows and the size of scales is reduced in the anterior part of body. The vent is longitudinal with lateral grooves forming a denticulate edge (some 8 denticles on each side); no gland is visible on sides of vent. Teeth: maxillary-premaxillary, 25-25; vomeropalatine, 21-21; mandibular, 19-19; splenial, 4-4. The tongue is broad, rounded, partially covering the splenial teeth.

Color in preservative for one hundred years: Dark brown above and on head, the edge of each fold distinctly lighter, nearly fawn-colored; eyes dark with whitish pupil surrounded by a narrow cream-colored ring; a cream-colored area about vent occupying

* Some previous authors have suggested that there are two transverse folds to each body segment in Caecilians. This is certainly not true in all cases, since the vertebrae of all specimens from S. E. Asia number less than half and often only a third of the number of transverse folds. Thus it must appear that numerous vertebrae have more than two transverse folds.

space between the interrupted folds; area about nostril dull cream; grooves on throat lighter than surrounding color. In life the color is said to have been violet-brown.

Measurements in mm.: Total length 226 (Bleeker's measurement 232) width of body, 10; width of head, 7; head length 9; largest scales, 2 mm. in diameter; width in body length approximately 22-23 times.*

Remarks: The specimen has been somewhat dehydrated and the back part of the body has had the folds loosened.

Ichthyophis singaporesis ** sp. nov.

Ichthyophis glutinosus, var. Cantor, Journ. Asiat. Soc. Bengal, vol. 16, p. 1058, and reprint in "Miscellaneous papers relating to Indo-China for Straits Branch of Royal Asiat. Soc.", vol. 2, Trübner and Co., London, 1886, p. ?; Boulenger, Catalogue of the Batrachia Gradientia s. Caudata and Batrachia Apoda in the Collection of the British Museum, 2nd ed., 1882, p. 91.

Type: British Museum No. RR. 1959.1, 2.43. Singapore. ***

Diagnosis: A small species having 267 primary and secondary folds about the body, 7 confined to short tail; maxillary-premaxillary teeth, 24-24; vomeropalatine, 20-20; mandibular, 20-20; splenial, 3-3. Orbit completely surrounded by bone; the tentacular opening in maxillary bone close to lip, nearer to eye than to nostril; separated from orbit by bone for a distance greater than the diameter of the opening. Total length of type, 243 mm. Tail length in total length 54 times; body width in total length 22 times. Vertebrae 111.

Description of type: (External characters of the head missing; its general characteristics and size may be derived from the skull measurements given). Tentacular opening near lip, closer to eye than to nostril; estimated head length, 10 mm.; estimated width of head, 7.5; first nuchal groove can be traced around head, most distinct below; second nuchal groove distinct below, not reaching dorsal surface of neck; third groove seemingly distinct dorsally and more or less distinct ventrally.

Scales present in first transverse folds, large, and in one or two continuous rows about body (except median point on venter). These continue throughout body, the rows growing more numerous in each fold until posteriorly there may be 7 or 8 rows in a single fold, the fold 3 to 3.2 mm. wide, the scales imbricating and overlapping laterally, as well as passing entirely around body. Many

* The partial dehydration of the specimen has changed the measurements.

** Singapore + ensis = place, locality, country.

*** The skin of the head had been loosened from about the skull to expose the skull while it was still attached to the vertebral column. The skull has now been placed in a small glass container attached to the type specimen.



FIG. 5. *Ichthyophis singaporensis* sp. nov. Type. Radiograph showing 111 vertebrae.

scales in posterior folds visible through the skin in this specimen (probably due to state of preservation); elongate recumbent glands opening between the folds. Transverse folds, dorsolateral count, 267, with 7 confined to tail; first three chevron-shaped folds on dorsum above pharynx occurring between the two posterior nuchal grooves, do not reach ventral part, but have well-developed scales; the fourth and succeeding folds completely surround the body, ventrally forming an angle, the transverse grooves seemingly not traceable on ventral parts until a short distance in front of vent where the folds and grooves cross venter without forming an angle;

vent longitudinal, interrupting four folds. Vertebrae 111. (Tooth formula in diagnosis.)

Color in preservative: Dull dark brown; if a cream spot occurs at vent it has now been discolored; a rather broad cream line borders the lower edge of each lower jaw, a darker line separating this from the lip; no cream spots discernible at eye, tentacle, or nostril.

Measurements in mm.: Total length (estimated for missing head based on skull length), 243; tail, 4.5; estimated width of head, 7.5; length of head, 10; body width, 11; width in length, 22 times; tail in total length, 54 times.

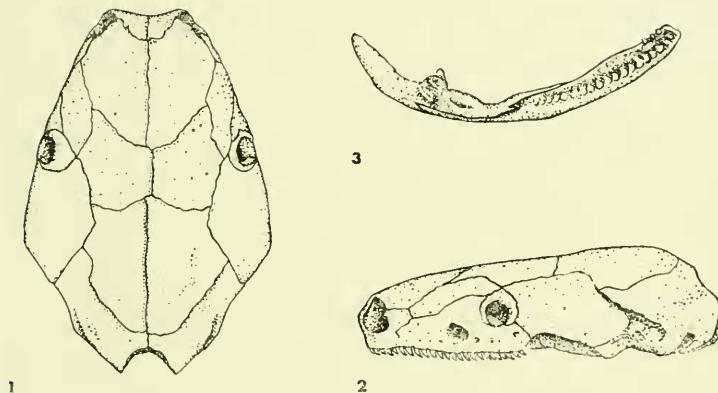


FIG. 6. *Ichthyophis singaporensis* sp. nov. Type. Fig. 1, dorsal view of skull; fig. 2, lateral view of skull; fig. 3, lower jaw, much enlarged.

Remarks: Figures of the skull show most of the important relations of the bones of the skull. One of the most significant features is that the orbit is closed completely and widely separated from the tentacular opening in the maxillary.

Figure 28,* *Epicrium glutinosum* given by Wiedersheim offering a lateral view of the skull shows the tentacular canal continuous with and forming a forward and downward extension of the orbital cavity. I am uncertain of the source of the specimen figured by Wiedersheim and cannot be certain that it even represents *glutinosus* as here considered. However it suggests the possibility that two genera are involved.

It is with some reluctance that I have used this ancient specimen, now badly mutilated, as a type specimen. The characters however, point to a distinct species. It came from a garden on Singapore

* Die Anatomie der Gymnophionen. Jena 1879, Plates: 2, fig. 23; 3, figs. 25, 26, 28, 29, 31; 4, figs. 35, 38 to 42, 43; 6, figs. 62, 69, 70; 7, figs. 75, 80; 9, fig. 88.

Island and to the best of my knowledge is the only specimen that has been reported as having been captured there despite the intervention of at least one hundred eleven years. I failed to find it during a stay of some weeks on the Island. If the specimen actually came from some other locality it is no less remarkable since it has not been reported elsewhere.

That the species may be related to *Ichthyophis monochrous* is shown in the body proportions, and the reduced splenial teeth. They differ however in the development of the scales, and the number of transverse folds is somewhat larger in *singaporenensis*. The matter of relationships cannot be decided until the skull characters of *I. monochrous* are known.

Ichthyophis dulitensis * sp. nov.

Ichthyophis monochrous Boulenger, Proc. Zool. Soc., London, 1892, p. 508
(Mt. Dulit, Borneo).

Type: British Museum of Natural History, No. 92.6.3.23, Mount Dulit, Sarawak, Borneo; elevation above 2000 feet; collected by Mr. Charles Hose, autumn 1891.

Diagnosis: A mountain species, 235 mm. in length, having 114 vertebrae and 313 transverse folds; splenial teeth reduced (4-4); the body width in length about 29 times; head of lighter color than body; a large cream spot on chin and throat; pharyngeal region darker than body or head.

Description of the type: A moderately slender species, the width in length approximately 29 times; head width at first nuchal groove, 8 mm.; the length of head, 11 mm.; width between eyes, 5.15 mm.; length of snout in front of eyes, 4.2 mm.; eye small with a white pupil surrounded by a black iris, slightly elevated on surface of head, its diameter, .9 mm.; head length from snout-tip to first nuchal groove, 10.5 mm.; to second groove, 13.2 mm.; to third, 17 mm.; tentacle conical, the opening hunate, the area about opening swollen, closer to eye (1.5 mm.) than to nostril (2.5 mm.); nostril and eye about equidistant from lip, the distance between them 3.4 mm.; the first nuchal groove is distinct on throat and sides of head but very dim or absent on dorsal part; second groove distinct on throat and discernible on side of neck, but not on the dorsal region; the third groove can be discerned on the sides of neck only.

The primary and secondary transverse folds, 313 (dorsal count; 304 ventral count); all grooves and folds appear to pass completely around the body throughout the length, tending to turn backward

* (Mt.) Dulit + ensis (Latin) = place, locality, country.

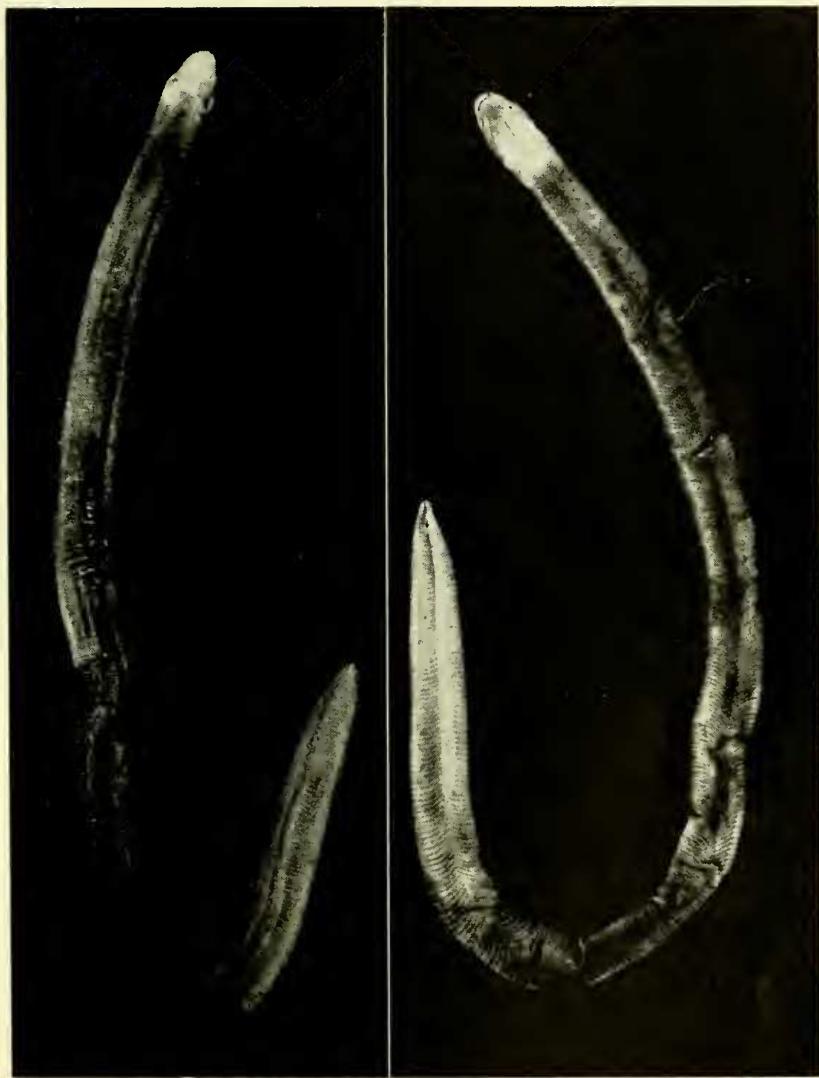


FIG. 7. *Ichthyophis dulitensis* sp. nov. Type. B. M. N. H. No. 92.6.3.23, Mt. Dulit, Sarawak, Borneo, elev. above 2000 ft. Left figure dorsal view, right figure, ventral view. Actual length, 235 mm. Note that the head of the left figure and the ventral side of the posterior part of the body are light struck. The white spot on the throat is natural.

and meet at an angle on ventral surface. The angles widen posteriorly and folds in front of vent pass almost directly across; seven folds on the tail (counted from front of vent); vent somewhat circular with a depression and groove following; a pair of tiny elevations on each side of vent suggesting glands.



FIG. 8. *Ichthyophis dulitensis* sp. nov. Type. Radiograph showing 114 vertebrae.

Scales present throughout body, those on anterior part much reduced in number and size. In posterior part there may be as many as four or five rows of scales in each fold, which partially overlap the scales of the following fold.

Teeth: maxillary-premaxillary, 18-18; vomerpalatine, 23-23; mandibular, 20-20; splenial, 4-4.

The tongue is rounded, perhaps not covering the splenials completely; choanae rather large, the diameter of one (.76 mm.) in the space between them (2 mm.), 2.63 times; the tail length in total length, about 42 times.

Color in preservative: Head olive brown; pharyngeal region very dark black-brown contrasting with both body and head; brown generally over body, the front part of the transverse folds darker than the remainder so that fine lines of dark brown appear to be alternating with fine lines of tan; a cream spot surrounding the vent and the depression following; a cream spot about tentacle and nostril; a small cream ring about eye. The large cream spot on throat somewhat broken up by brownish lines in the nuchal grooves.

Measurements in mm.: Snout to vent, 235; tail, 5.6; head length, 11; head width, 8; average body width, 8.

Remarks: This species, which geographically is close to the type locality of *Ichthyophis monochrous* is clearly differentiated from the latter species by the much larger number of primary and secondary folds (313 instead of 247), the presence of a cream spot on the throat, seemingly a different type of vent, a larger head, and six more vertebrae.

They agree in having a reduced series of splenial teeth, and the body folds have the same type of ventral angle.

From *I. weberi* it differs in having a series of splenial teeth; from *I. javanicus* in being less slender, in having a reduced series of splenial teeth (4-4 instead of 12-12) and fewer transverse folds (313 instead of 351); from *I. glandulosus* in lacking the lateral ridges, in having folds and grooves encircle the body, more transverse folds (313 instead of 273), and a reduced series of splenial teeth.

*Ichthyophis peninsularis** sp. nov.

Ichthyophis monochrous Boulenger, Catalogue of the Batrachia Gradientia s. Caudata and Batrachia Apoda in the Collection of the British Museum, 2nd Ed., 1882, p. 91, pl. 4, fig. 1 (*part.* Malabar); Fauna of British India, including Ceylon and Burma. Reptilia and Batrachia, 1890, p. 517 (*part.*); Ramaswami, Current Science, Bangalore, vol. 16, 1, 1947, pp. 8 to 10 (? *part.*).

Type: Brit. Mus. Nat. Hist., No. 82.12.12.6; Malabar, India, R. H. Beddome collector.

Diagnosis: A large species, with a broad, relatively short head; the eye invisible covered with a raised circular white spot; the tentacle nearer the eye-spot than to the nostril; tail long, its length

* Peninsula (Latin) referring to peninsular India.



FIG. 9. *Ichthyophis peninsularis* sp. nov. Type. B. M. N. H. No. 82.12.12.6,
Malabar, India. Actual length, 330 mm.

in total length nearly 22 times; the body width in length about 22 times nearer the eye-spot than to the nostril; tail rather long, its length in total length nearly 22 times; the body width in length about 22 times; transverse folds on dorsum, 363; folds on tail, 18; vertebrae, 116; splenial teeth, 4-4. Ventral surface very light, probably cream colored in life; a well-defined cream spot at vent.



FIG. 10. *Ichthyophis peninsularis* sp. nov. Type. B. M. N. H.
No. 82.12.12.6. Radiograph showing 116 vertebrae.

Description of type: Width of head (14.4 mm.) only a little less than length of head (16 mm.); distance between eye-spot, 7.1 mm. measured on the curve, greater than length of snout in front of eyes (6.1 mm.); tentacle withdrawn, the tentacular opening circular;

tentacle opens near lip between eye and nostril, closer to eye-spot (2.5 mm.) than to nostril (4 mm.); eye-spot and nostril equidistant from lip, the distance between them 5 mm. The anterior nuchal groove encircles the head; second fold well defined on neck, and somewhat on sides of neck; third fold more or less distinct except in the median ventral area; snout tip to first groove, 14 mm.; to second, 19 mm.; to third, 24 mm.; six anterior folds fail to meet below on the median line; the folds can be seen because of the distribution of the glands but the grooves themselves seemingly do not cross the venter except in the posterior part of the body; folds counted on dorsal surface, 363; on ventral surface, 363, forming an obtuse angle directed backwards except in the posterior part of body where they pass directly across; tail somewhat compressed laterally and pointed terminally; the vent interrupts eight folds; a total of 18 folds on tail from front of vent.

Scales are present throughout body, anteriorly somewhat smaller and sparse or absent ventrally; posteriorly there are from three to five transverse rows in each fold extending around the body; vertebrae, 116.

Teeth: maxillary-premaxillary, 24-25; vomeropalatine, 25-26; mandibular, 25-24; splenial, 4-4. The maxillary teeth are larger than the vomeropalatine series, but are somewhat smaller than the mandibular or at least the anterior ones.

Coloration in preservative: Above, grayish lavender growing lighter laterally and ventrally; underside with some pigment but light, perhaps cream-colored in life. Head somewhat grayish brown; the eye-spots whitish; small cream areas about tentacle and nostril.

Measurements in mm.: Total length, 330; tail, 15.2; width of body, 14.8; head width, 14.4; head length, 16.

Variation: A second specimen available agrees with the preceding in general; the following data are given for comparison: length, 258, tail, 11.8, width of body, 13, width in length, 20, head width, 11.8, head length, 14; transverse folds (dorsal) 366, tail folds, 18. Teeth; maxillary-premaxillary teeth, 20-20; vomeropalatine, 19-19; mandibular, 15-15; splenial, 3-4. The specimen is one recently collected and is darker than the preceding.

A Berlin specimen from Malabar is young, measuring 222 mm. in length. The transverse folds number 357, the vertebrae, 116, and the splenial teeth, 4-4. The specimen is light lavender to violet above; below, the chin and neck are cream-white, and the remainder

of the venter is dull cream. The head is lighter in color than the remainder of the dorsum.

Remarks: It is not impossible that the type is somewhat faded since it has been in preservatives considerably more than half a century. It is, however, in relatively good condition except that exploration of the mouth has injured the tongue and the skull is broken in the palatal area.

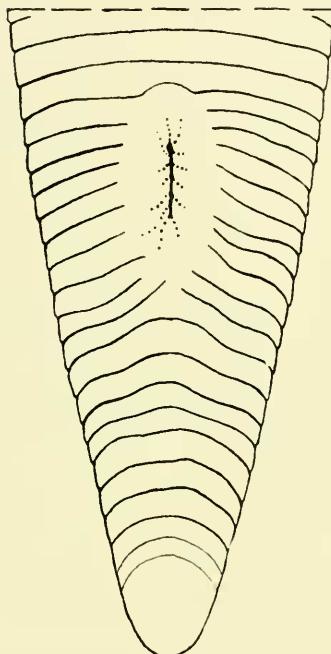


FIG. 11. *Ichthyophis peninsularis* sp. nov. Type. Characteristics of the subcaudal region. Enlarged.

*Ichthyophis subterrestris** sp. nov.

Type: Chicago Natural History Museum No. 73927, Travancore-Cochin, plains, India.

Paratype: Stanford Mus. No. 2118, from Kottayam, Travancore, India.

Diagnosis: Dark violet-lavender above and dark lavender-brown venter; a light area about nostril, but not about tentacle or vent; tentacular opening circular; mandibular teeth very large, approximately three times the size of teeth in maxillary series; splenial

* Sub (Latin) under + terrestris (Latin) = of the earth.

teeth, 5-5; 364 folds, 18 on tail. Total length, 260; tail, 11.7; tail length in total length, 22.2 times; body width in body length approximately 21 times.

Description of type: Head somewhat elevated posteriorly, the width at first nuchal groove 11 mm.; the length of head, 14 mm.; distance between eyes on curve (6-8 mm.) greater than length of snout (5.35 mm.); tentacle withdrawn, not attached to the edge of opening; the tentacular opening close to lip, circular; tentacle close to lip, much closer to eye (1.8 mm.) than to nostril (3 mm.); distance between eye and nostril, 4.3 mm. Distance from tip of snout to first nuchal groove, 13 mm.; to second, 16.8 mm.; to third, 20.2 mm. (measurements made on side of head).

Primary and secondary folds together 364, of which 18 are on tail; these cross the body, and form angles ventrally, except posteriorly; first four or five failing to meet on throat, eight interrupted by vent; anterior folds curve forward across neck; the grooves are not complete on venter except in the posterior part of the body; small scales are present from the first fold, both dorsally and ventrally, only one or two sealerows usually present; farther back scales increase in size and number the posterior folds having four or five rows, the first row of each series smallest, the one preceding the last largest, all imbricating.

Teeth: maxillary-premaxillary, 21-21; vomeropalatine, 21-21; mandibular 17-17; splenial, 5-5. The size of the teeth is such that the tiny notch near the outer anterior face of the tooth can be seen. The tongue is large, completely covering the splenial teeth, the anterior part broadly arrow-shaped and somewhat elevated. It seems probable that some of the posterior splenial teeth are missing since the paratype has a somewhat larger number.

Tail laterally compressed, the terminal part without folds (true in practically all species); a pair of darker areas along side of vent perhaps representing the position of special glands; choanae somewhat angular on their inner face, separated from each other by a distance equal to three times the transverse diameter of one.

Color in preservative: Dark violet-lavender above, becoming brownish-lavender on venter; slightly lighter about eye; however, a few small rounded flecks, presumably glands are present close to eye; a dull cream area about nostril; area about vent lighter than surroundings (perhaps originally cream).

Measurements in mm.: Total length, 260; tail, 11.7; tail in total length, 22.2 times; body width, 12.4; head width, 11; head length, 14.

Remarks: The absence of calcium in the body was discovered on examining an X-ray picture of the specimen. There is no trace of the skeleton to be discerned. This absence is probably caused by the method of preservation. It is a relatively recent specimen and whatever the chemical, so effective in dissolving calcium, it seemingly has not affected the color and texture of the other tissues.

The paratype agrees with the type in very considerable detail except that the skeleton is intact and there are three more splenial teeth on each side. The characteristics of the scales and their distribution are those of the type. There are 356 folds, 16 on tail.

The maxillary-premaxillary teeth are about 27-27; the vomeroplatines, 25-28; the mandibular, 20-20; and splenials, 8-8. The length is 295 mm. The skin on one side of the head has been removed disclosing the orbit and the tentacular groove. The latter is completely separated from the orbit occurs in *singaporenensis*, as is indicated in fig. 6. The shape of the tentacular opening is somewhat more rectangular. The increase in number of teeth may be due to age.

This species is seemingly distinguished from other species of the Indian Peninsula by the following combination of characters: the shape of the tentacular opening; the elongate tail with the high number of folds; the tail length being contained in total length only 22.2 times; the enlarged mandibular teeth. The color of the venter separates it from *peninsularis* and the body proportions seem to be somewhat different.

*Ichthyophis bombayensis** sp. nov.

Type: British Mus. Nat. Hist. No. 86.6.11.1, Waghii Surrat, Bombay, India; Gleadon, collector.

Diagnosis: A large species (390 mm.) having 386 transverse folds, 14 confined to tail; splenial teeth 9-9; body width in length, 26 times; vertebrae, 121; color in preservative, dark brown above, somewhat lighter brown below; tail relatively long contained in total length about 25 times; tongue tending to cover the splenial teeth; mandibular teeth much larger than maxillary-premaxillary series; vomeropalatine teeth relatively small, scarcely extending through the thick gums.

Description of type: Head proportionally small, its width at first nuchal fold 10 mm., the length 15 mm.; eye distinct, the lens a pearly sphere surrounded by a narrow black rim of iris and these in turn surrounded by a light ring on skin wider above eye, very nar-

* Bombay + ensis = place, locality, country.

row below; tentacular opening somewhat rounded, the tentacle a fine slender cone seemingly not attached laterally to the opening; tentacular opening about half a millimeter from lip, closer to eye (2.3 mm.) than to nostril (4 mm.); eye from nostril, 5.5 mm.; eye from lip, 1.9 mm., nostril from lip, 1.8 mm.; distance between eyes (on curve), 8 mm.; length of snout, 7 mm.; distance between nostrils, 4 mm. First nuchal fold well visible above on sides and on underside of neck, preceded by a distinct strongly curving fold on back of head beginning above mouth angle, not visible on sides or

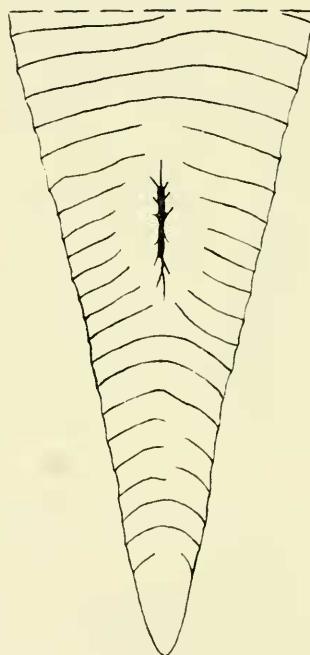


FIG. 12. *Ichthyophis bombayensis* sp. nov. Type. B. M. N. H. No. 86.6.11.1. Waghii Surrat, Bombay, India. Actual length, 390 mm.

below; second nuchal fold not discernible on sides or above, distinct below; third nuchal groove strong on sides, less so on dorsum, partly crossing venter. Snout to first nuchal groove (lateral measurement), 15 mm.; to second, 20 mm.; to third, 27 mm.

Transverse folds on body, 386; 13-14, folds confined to tail; tail rather strongly compressed laterally; transverse folds make a median forward curve dorsally, then on sides tend to turn back and form a median ventral angle at a point five to seven millimeters behind its most anterior point above. Scales are present throughout, anteriorly

usually only a single row in each fold, more posteriorly there may be three imbricating rows, the middle one much the largest in each fold.

Teeth: maxillary-premaxillary, 23-22; vomeropalatine, 24-24; mandibular, 20-20; splenial, 9-9.

Color in preservative: Above dark brown the posterior edge of the folds a little lighter; top of head somewhat mottled with darker brown; venter lighter brown; a cream spot surrounding vent. A small light area around eye; a cream spot below tentacle and one about nostril; lips and an area at mouth-angle cream.

Measurements in mm.: Total length, 390; tail, 15.2; head width, 10; head length, 15; width, 15; width in length, 26 times; tail length in total length, 25.6.

Remarks: The increased number of vertebrae, the coloration, the enlarged mandibular teeth and the reduction of the size of the vomeropalatine teeth seem to separate this from more southern Indian forms. The specimen is a male.

Ichthyophis mindanaoensis * sp. nov.

Ichthyophis monochrous Inger, Fieldiana Zool., vol. 33, no. 4, 1954, pp. 207-209 (part.); Todaya on Mount Apo, Davao Province, Mindanao, P. I.

Type: Chicago Natural History Museum No. 50958, Todaya, Mt. Apo, Davao, Mindanao, P. I., 2800 feet elevation, H. Hoogstral, collector.

Paratype: C. N. H. M. No. 50957, Mt. McKinley, Davao, Mindanao, P. I.

Diagnosis: A medium-sized species, largest known specimen, 276 mm. (283 fide Inger). Vertebrae, 110-116; transverse folds, 308-317; 322-341; body width in length approximately 28; tail length in total length approximately 43 times; splenial teeth, 8-8 to 11-11. Single gill opening on each side in larvae.

Transformation occurs in larvae after a length of 238 mm. has been reached, the large larvae retaining the lateral line system clearly defined on head. Differs from *glandulosus* (from Basilan, P. I.) in having 8 to 14 more vertebrae, more (30 or more than highest count) transverse folds. The choanal openings are at least one half larger.

Description of type: Head rounded, oval; snout projecting somewhat; eyes visible, covered with skin that forms a slightly raised circular area, dark in the middle and ringed with gray; width of

* Mindanao + ensis (Latin) = place, country of.

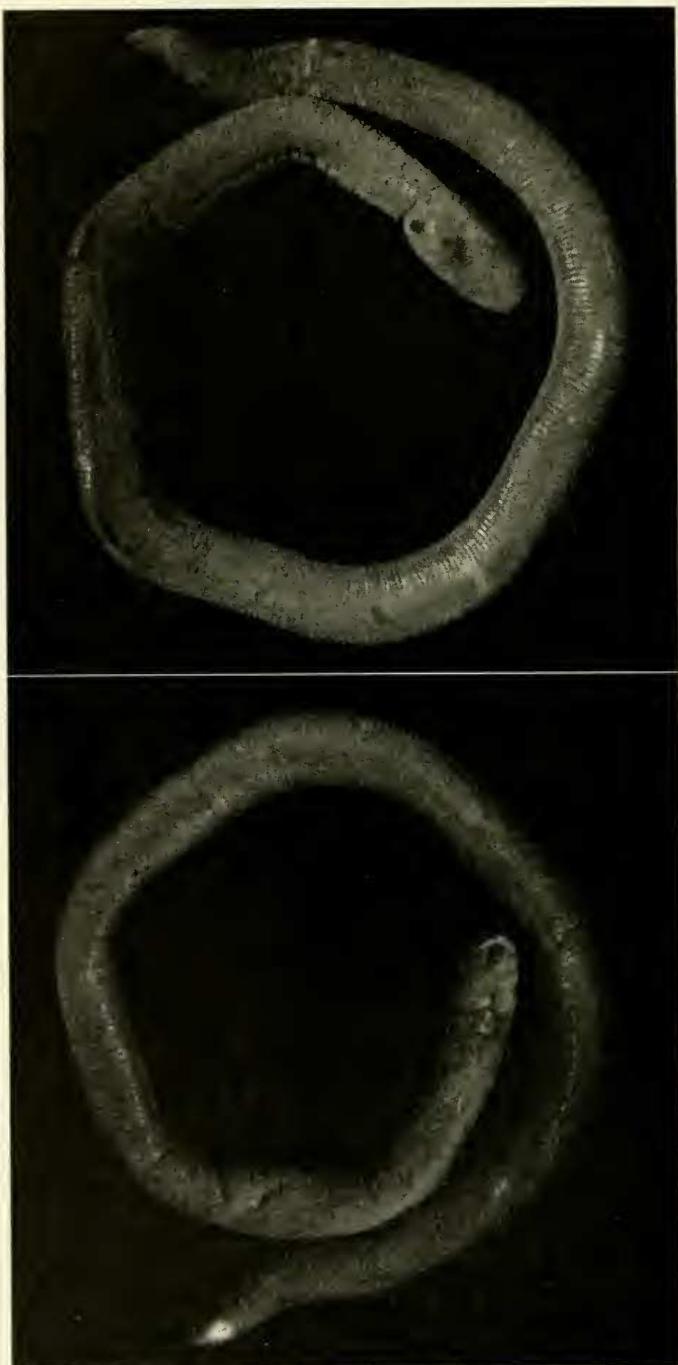


FIG. 13. *Ichthyophis mindanaensis* sp. nov. Type. Chicago N. H. M. No. 50958. Todaya, Mt. Apo, Davao, Mindanao, P. I. 2800 ft. elev. Upper figure, dorsal view; lower figure, ventral view. Actual length, 276 mm.

head at first nuchal groove, 9.3 mm.; length of head, 14 mm.; tip of snout to first nuchal groove, 12 mm.; to second, 15 mm.; to third, 20 mm.; distance between eyes measured on curve (6 mm.) longer than snout (5.1 mm.); the first nuchal groove distinct on throat can be traced across top of head; second, distinct on throat and on side of neck for a short distance; third, visible across dorsum and on sides, scarcely or not discernible on throat. Tentacular opening hinate, near edge of lip, much closer to eye (1.5 mm.) than to nos-



FIG. 14. *Ichthyophis mindanaensis* sp. nov. Upper fig., type; lower fig., paratype. C. M. N. H. No. 50951, Mt. McKinley, Davao, Mindanao, P. I.

tril (3.6 mm.); distance between eye and nostril, 4.5 mm.; nostril closer to lip than eye. Transverse folds, 305, six confined to tail; folds and grooves complete across dorsum, the grooves failing to cross the middle part of venter except on the latter fourth or fifth of body. The vent interrupts three folds.

Choanal openings large, the distance between the edges of the choanae, 2 mm.

Scales present; anteriorly sparse, small, usually in a single row on dorsum in each fold; more posteriorly the scales increase in size and number until there are three or four rows surrounding the body in each fold. Vertebrae, 111.

Teeth: maxillary-premaxillary, 25-26; vomeropalatine, 24-24; mandibular, 17-18; splenial, 8-8.

Color in preservative: Above plumbeous-violet to brownish, the venter a slightly lighter shade; a cream spot covering vent, one about tentacle and one around nostril; a gray ring surrounds eye connecting with a gray area lying between eye and tentacle; some fine light areas under throat on midline. Lips lighter than sides of head; under clear liquid the body segments can be discerned along the median ventral line, as indicated by slightly darker transverse marks.

Measurements in mm.: Total length, 276; tail, 6.4; width of body approximately, 9.8; head width, 9.3; head length, 14.

Remarks: There is a second adult specimen in the collection from Mt. McKinley, Mindanao, P. I., taken at an elevation of 3000 feet, that may belong in this species. The specimen is 7 mm. longer than the type of *mindanaoensis* and has 113 vertebrae; there are 308 folds, 9 of which are confined to the tail. The scales are scattered, or absent and small when present on the anterior half of the body; at first only a single row present but in the posterior folds there are three rows, transversely overlapping, and imbricating.

Larvae: There is a series of larvae taken at Todaya, Mt. Apo, 2800 feet elevation, "to be found in rivers and on the ground during rain," that presumably represent this species. These specimens are recorded in the accompanying table.

The neuromast (lateral line) system is retained and is especially distinct in all but the largest larvae. It would appear that this is an adaptation for life in deeper waters such as rivers as opposed to brooks. In most of the species studied only the small and presumed very young larvae showed the organs clearly. The larvae are large at the time of transformation (238 mm.).

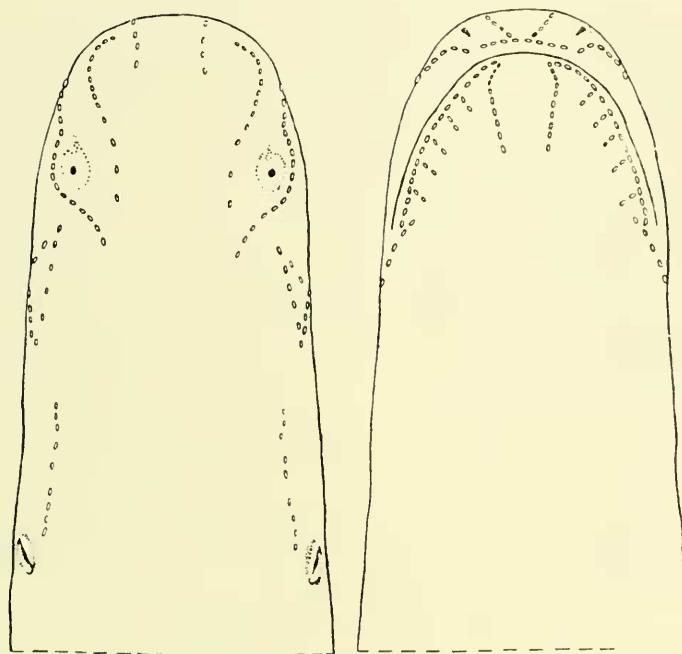


FIG. 15. *Ichthyophis mindanaoensis* sp. nov. Paratype larva. C. M. N. H. No. 50970, topotype. Actual length, 220 mm. Showing the details of the neuromast system in large larvae. Actual length, 220 mm.

Table of data on larval specimens presumed to be young of *Ichthyophis mindanaoensis* sp. nov.

NUMBER	Length	Vertebrae	Body folds
50966	69	.....	.....
50967	98	.....	.....
50973	120	.....	.....
50969	150	.....	.....
50968	156	.....	.....
50961	191	.....	.....
50960	220	116	320
50970	220	116	327
50963	224	114	344
50964	231	114	330
50975	236	116	341
50971	236	116	324
50972	237	114	302
50976	238	114	334

Dr. Inger, with his characteristic graciousness, has kindly permitted me to study these adult specimens from Mindanao and the larval series which may be of the same species. Our findings are,

of course, quite different. I cannot agree that these specimens are conspecific with *Ichthyophis monochrous* Bleeker, *Ichthyophis glandulosus* Taylor and *Ichthyophis weberi* or with any one of them.

Dr. Inger's diagnosis of *I. monochrous* reads as follows: "Body cylindrical or slightly depressed, elongate; numerous annuli around the body; eye small, covered with skin; tail short, pointed; anal opening a longitudinal slit." A half or more of the known caecilians might easily fit this diagnosis and certainly the above mentioned species would thus be included in *Ichthyophis monochrous*.

His description is perhaps a composite made up from his specimens and from the literature since his variation in annular rings is somewhat greater than is shown in the Mindanao material.

Dr. Inger states that there is no tentacular aperture but he has overlooked this in the oldest larvae where a pit or aperture appears in the eye area; he also states that there are no spiracles, but these are certainly present in 14 of the larvae studied and are probably present in the entire 18 mentioned.

Ichthyophis glandulosus Taylor

Ichthyophis glandulosus Taylor, Philippine Journ. Sci., vol. 21, no. 3, Sept. 1922, pp. 516-517, pl. 3, figs. 4, 5 (type locality, Abung Abung, Basilan I., P. I.).

Ichthyophis monochrous Inger, Fieldiana Zool., vol. 33, no. 4, July 23, 1954 (parts).

Ichthyophis Taylor, Distribution of life in the Philippines, Bureau of Science, Monograph, no. 21, Manila, 1928, p. 219 (Zamboanga).

Diagnosis: A medium sized species (largest known specimen 250 mm.); 273 transverse folds and grooves, meeting on dorsum in neck region and in the latter two fifths of body, rarely meeting on venter except in latter part of body; inner mandibular splenial teeth 11-11; tongue somewhat pointed anteriorly rather than rounded; distinct dorsolateral ridges. Vertebrae, 102.

Redescription of type: Cal. Acad. Sci. No. 60073 Abung Abung, Cotobato, Mindanao, P. I. Moderately slender, the length, 250 mm., the width of body, 11 mm., the width in length about 23 times; eyes very dim, but visible, the distance between them (measured on the curve), 5.8 mm.; snout length in front of eyes, 4.5 mm.; width of head at first groove, 9.3 mm., length of head, 12.5 mm.; eye slightly elevated, its diameter, .95 mm.; tentacle not exserted, the opening vertically lunate, situated very close to edge of lip, 1.3 mm. from eye, and 3.5 mm. from nostril; nostril and eye each about 1.2 mm. from lip; tip of snout to first groove, 11.5 mm., to second, 15

mm., to third groove, 17.2 mm. (these three measurements are made on the side of head and neck).

First nuchal groove deeply marked on throat and on sides, less distinct dorsally and not, or but dimly crossing dorsal area; third groove distinct laterally but only faintly indicated on ventral and dorsal surfaces. Grooves following do not meet on the ventral part of body except the 22 preceding vent; the first 22 meet dorsally, and the terminal 70 grooves meet. The folds do not meet dorsally throughout much of body where grooves fail to meet (or their meeting not discernible); four folds interrupted by vent.

Scales present posteriorly, three or four rows of scales in each fold. Farther forward there may be only two rows of very small scales; and anteriorly they seem to be entirely absent in first 40 or 50 folds, perhaps more. When present scales of one fold tend to overlie partially those in the following fold, although separated by tissue.

There are 273 folds altogether, six on tail; posteriorly, where they can be seen to meet, they form a slight angle directed posteriorly; a pair of sharply defined lateral folds or ridges extend throughout body to within 2.5 centimeters of the tail tip.

Skin glands are present throughout the body and many can be seen through the skin; the largest ones seem to have their openings along the edges of the grooves and tend to lie recumbent in rows below the scales. There are two swollen areas on each side of the anterior part of the vent suggesting special glands. Vent longitudinal, the edges denticulate; the terminal part of tail lacking folds; sides of tail slightly compressed, the tip somewhat pointed.

Teeth: maxillary-premaxillary, 23-23; vomeropalatine, 24-24; mandibular, 21-21; splenial, 11-11. The tongue pointed rather than rounded, partially covering the splenial teeth; choanae small, the transverse diameter about .35 mm., contained into distance between them about 6 times.

Color in life: "Deep lavender to slate; more olive than lavender on venter. In formalin the specimen is brownish-lavender with scattered deep purple markings." After 38 years in alcohol the specimen brownish, with a slightly lighter brown venter, the purple marks indicated. A cream area around vent.

Measurements in mm.: Total length, 250; tail from front of vent, 6.2; head width, 9.3; head length, 12.5; width of body (average) about 11; width in length approximately 22.7 times.



FIG. 16. *Ichthyophis glandulosus* Taylor. Type. Cal. A. S. No. 60073, Abung Abung, Cotabato, Mindanao, P. I. Actual length, 250 mm.

Variation: There are three paratypes; one measuring 165 mm. was (in life) a deep slate-purple; the lateral folds are present in all. The posterior part of the head is less widened than in the adult.

The specimens were obtained under fallen logs in moist situations along a small forest stream in southern Basilan. The species can be separated from *Ichthyophis weberi* by the long series of splenial teeth (11-11), none in *weberi*, and the low number of folds about body (273 compared to 324 in *weberi*), and the fact that the grooves do not cross the dorsum throughout much of the body. From *monochrous* it may be separated, by the failure of the grooves to meet on the mid-ventral line in much of the body, in the longer series of splenial teeth and in the presumed greater number of body folds (273 compared to 247 in the type of *monochrous*), and fewer scales in each fold.

Remarks: A specimen of *Ichthyophis* was taken near the city of Zamboanga, in the Province of Zamboanga, Mindanao, Philippine Islands in 1923. I was unable to make a study of the specimen but it was tentatively identified as "*Ichthyophis (?) glandulosus* Taylor." On my return to Manila in 1957 I learned that this specimen as well as the type of *Ichthyophis weberi* had been destroyed in the final battle fought in Manila of World War II. A last stand was made by the Japanese in that section of the building where I formerly had my office and which housed the extensive herpetological and ichthyological collections. All collections were destroyed. There is no certainty that the species was *glandulosus*. The paratype material is not now available to me for study.

*Ichthyophis javanicus** sp. nov.

Type: British Museum of Natural History, No. 80.5.7.3. Collected, "Java" the exact locality not known.

Diagnosis: A slender species, the greatest known length, 210 mm., the body width, 6 mm.; the tail length, 4.5 mm.; width in length, 35 times; splenial teeth, 12-12; vertebrae, 115; primary and secondary transverse folds, 351 dorsal, — 348 ventral count; ten folds on tail, five interrupted by longitudinal vent; tentacle nearer to eye than to nostril.

Description of type: A slender species the head slightly elevated, the height of head about 2.4 mm.; width between eyes, 4.5 mm.; length of snout anterior to eyes, 3.5 mm.; width of head at first nuchal groove, 6 mm.; length of head, 9.4 mm.; eye very distinct,

* Java + icus = belonging to, pertaining to.

the pupil white, the iris black with a very small cream area in front of eye; an incomplete ring of whitish flecks about eye; tentacle close to edge of lip, the tentacle conical seemingly somewhat rounded at tip, the tentacular opening lunate; tentacle nearer to eye (1 mm.) than to the nostril (2.3 mm.). First nuchal groove clearly indicated only on sides of head (or neck) but on throat vaguely indicated; second groove vaguely indicated on sides and



FIG. 17. *Ichthyophis javanicus* sp. nov. Type, B. M. N. H. No. 80.5.7.3.
"Java." Actual length, 210 mm.

underside of neck; third groove no different in appearance from a primary costal groove; pharyngeal region not wider than head; tip of snout to first groove, 9 mm.; to second groove, 11.7 mm.; to third, 13.7 mm.

Approximately 351 primary and secondary folds surrounding body, meeting on the median ventral line at an angle which becomes broader posteriorly; ten folds on tail of which five are interrupted by vent; the transverse grooves likewise appear to surround the body; scales on anterior part of body absent or very small and scattered; posteriorly the scales form transverse rows, the scales overlapping, usually only one or two rows present

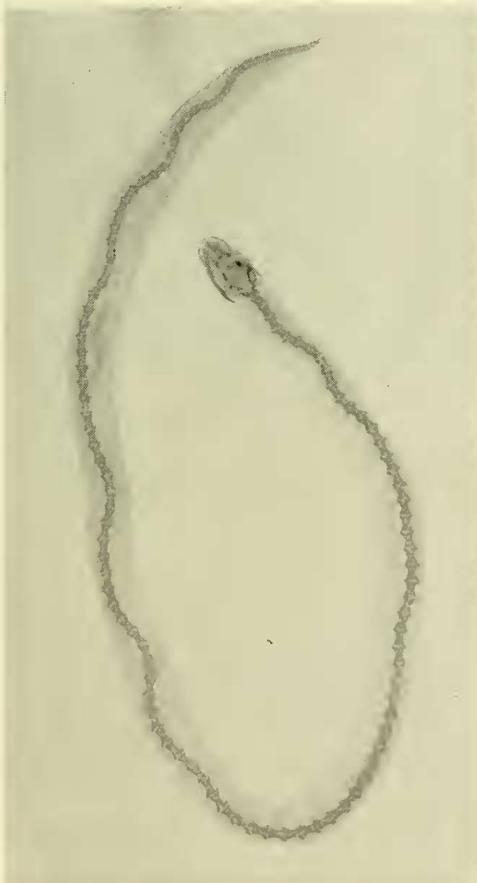


FIG. 18. *Ichthyophis javanicus* sp. nov. Type. Radiograph showing 115 vertebrae.

in each fold, the scales varying much in size. There are no dorso-lateral ridges evident.

Teeth: maxillary-premaxillary, 19-19; vomeropalatine, 18-19; mandibular, 19-19; splenial, 12-12; the mandibular teeth largest, the splenials smallest; the tongue is somewhat narrowed anteriorly not covering the vomerine teeth.

Color in preservative: Entire body brown, the ventral surface only slightly lighter in shade; a cream-colored area about tentacle and nostril; a cream spot on vent widened anteriorly; the anterior edge of each fold slightly darker than remaining part.

Measurements in mm.: Total length, 210; tail length, 4.5; head width, 6; head length, 9.4; eye to nostril, 3.

Remarks: This species is easily differentiated from *Ichthyophis glandulosus* in having 78 more primary-secondary folds; from *I. monochrous* in having 104 more folds, and 115 rather than 108 vertebrae; from *I. weberi* in having a well-developed series of splenial teeth in the lower jaw (none in *weberi*). The specimen is attributed to "Janson" in the British Museum Catalogue.

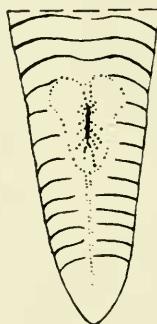


FIG. 19. *Ichthyophis javanicus* sp. nov. Type. Ventral view of caudal region; enlarged.

Ichthyophis malabarensis * sp. nov.

Type: Brit. Mus. Nat. Hist., No. 94.3.15.3, Maduvangard, Travancore, India; Ferguson, Collector.

Diagnosis: The largest oriental species known, reaching a length of about half a meter. Tail proportionately long, its length in total length 23.5 times; body width in total length about 27 times; transverse primary and secondary folds, 360, 14 on tail; vertebrae, 111; splenial tooth series, 10-10; other teeth numerous; tentacular open-

* Malabar + ensis, place locality of.



FIG. 20. *Ichthyophis malabarensis* sp. nov. Type. B. M. N. H. No. 94.3.15.3. Maduvangard, Travancore, India. Actual length, 494 mm.

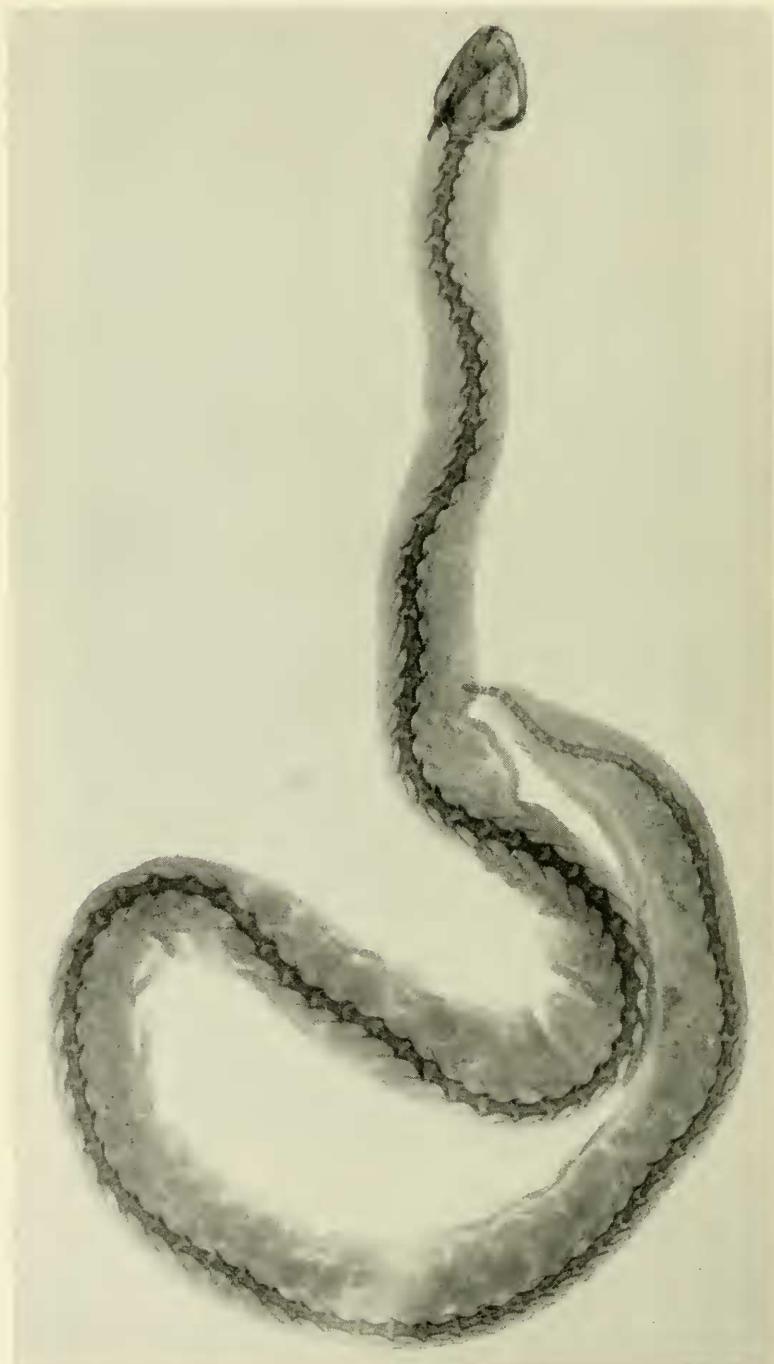


FIG. 21. *Ichthyophis malabarensis* sp. nov. Type. Radiograph showing 111 vertebrae.

ing close to edge of lip, nearer eye than to nostril; scales throughout body in four to five rows in each fold.

Description of type: Head broadly oval; the distance between the eyes (11 mm.) greater than length of snout in front of eyes (8.4 mm.); tentacle situated close to lip, closer to eye (2.6 mm.) than to nostril (5 mm.); distance between eye and nostril, 6.7 mm.; width of head at first transverse groove, 14 mm., the head length, 21 mm.; tip of snout to first groove, 19 mm.; to second, 26 mm.; to third, 32.3 mm.; two transverse folds appear anterior to the third nuchal groove that are incomplete; 360 primary and secondary folds encircle body forming on venter obtuse angles directed backwards, meeting on the mid-line except on posterior part of body where they pass straight across venter; on dorsal surface they are continuous, but anteriorly on the median line they tend to form a very obtuse angle, directed forward.

Scales are present throughout the body, those on anterior folds being small, sparse; posteriorly the scales increase in size and number of rows in each fold. Posteriorly the scales may measure 2.5 to 3 mm. in diameter. They tend to form four or five imbricating rows, the scales of one row overlapping laterally those of the same row. The series of one fold tend to overlie partially those of the following fold; vent longitudinal, interrupting six folds, which tend to bend forward on venter; no glands visible on region of vent; tail pointed, somewhat laterally compressed, with 14 folds, the terminal portion without folds.

Teeth: maxillary-premaxillary, 28-30; vomeropalatine, 30-28; mandibular, 28-28; splenial, 10-10; the maxillary-premaxillary teeth are larger than the vomeropalatine; the mandibular considerably larger than the maxillaries; the splenials distinctly smaller than the vomeropalatinates.

Coloration in preservative: Dark brown dorsally, the anterior part of each fold darker than the posterior; laterally the color is lighter and becomes nearly cream on underside of body. Head above and on side, and anterior part of body somewhat mottled; a transparent ring around eye, showing the bony border of the orbit continuous; a cream spot on nostril; a small inconspicuous cream mark around vent.

Measurements in mm.: Total length, 494; tail, 21; body width (average), 18; head length, 20.2; head width, 14.5.

Remarks: It would appear that this species is rare in its range or that it burrows to a considerable distance below the surface of

the earth. A creature so conspicuous would otherwise be better known.

Despite the fact that it is the largest caecilian reported from Asia it has a relatively low number of vertebrae (111). The number of folds likewise is low when compared with certain other Indian forms treated here in this paper. The number of folds on the tail is 14, likewise a lower number than occurs in certain other Indian forms.

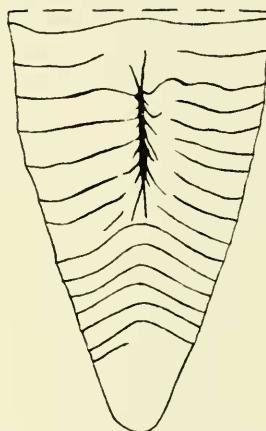


FIG. 22. *Ichthyophis malabarensis* sp. nov. Type. Ventral view of caudal region. Enlarged.

The specimen is a female containing many large eggs (5-6 mm. in diameter), the number estimated to be more than 60.

The figure of *Ichthyophis glutinosus* given in Wiedersheim (*Die Anatomie der Gymnophionen*. Taf. B, fig. 28) shows the orbit incomplete and continuous with the tentacular depression. It is probably impossible to determine the source of Wiedersheim's material. In this species the orbit is complete.* The mottled appearance, darker brownish marks on the anterior third of the body, is I believe a normal coloration and not due to preservation. The marks are more clearly evident when the specimen is submerged in a clear liquid.

Ichthyophis youngorum sp. nov.

Type: EHI-HMS No. 35946, Doi Suthep (Sutep), Chiang Mai, Thailand, at approximately 1200 m. in elevation; collected by Edward H. Taylor, July 12, 1957.

* The orbit is also complete in a specimen of *I. singaporenensis* as well as perhaps in other species now placed in this genus. One may question whether these are congeneric with Wiedersheim's specimen.



FIG. 23. *Ichthyophis youngorum* sp. nov. Type. E. H. Taylor No. 35946, Doi Suthep, Chiang Mai, Thailand. 3900 ft. elev. Actual length, 210 mm.

Paratypes: EHI-HMS Nos. 35944 adult; Nos. 35932-35941 larvae all topotypes, July 12-15, 1957, same collector.

Diagnosis: A medium-sized species having large larvae (to 240 mm.); primary and secondary folds, 314-326; body width in length 16-17.5 times; splenial teeth, in adults to 12-12; largest adult seen, 220 mm. Scales absent in at least anterior third of body; reduced to a single overlapping row in each fold where present; vertebrae 106-107.

Description of type: A species of medium size, the body width in length 17.5 times; width of head, 9 mm., its length, 12 mm.; distance between eyes, 4.9 mm.; length of snout, 4.3 mm.; tentacle small, cone-shaped, the opening lunate, closer to eye (1.3 mm.) than to nostril (2.6 mm.).

First nuchal groove dimly visible on throat. Second groove visible on throat but reaching the level of the mouth on side; third groove barely indicated, not strong even laterally; a longitudinal groove on chin extending on to throat. Snout-tip to third groove, measured laterally, 16.5 mm.

The primary and secondary folds total 324 but many fail to reach venter. The count on side is 304, on venter 280; four folds interrupted by longitudinal vent; six folds on tail; a pair of dorsolateral ridges indicated; transverse folds meet on venter at a broad angle except posteriorly where they pass straight across venter. Scales absent anteriorly, present in latter two thirds of body; when they begin they are small, much wider than long; posteriorly they are larger, with a single overlapping row in each fold; vertebrae 107.

Teeth: maxillary-premaxillary, 21-22; vomeropalatine, 21-22; mandibular, 20-20; splenial, 12-12.

Color in life: General color above, violet to lavender; the venter lavender; the grooves (partly due to glands in the skin) appear light gray; chin blackish brown; head darker, nearly uniform plumbeous; a gray-white spot in front of eye more or less connected with a gray spot about tentacle; a slightly distinct light area about nostril; the edges of the vent are gray flesh with two small glands.

Measurements in mm.: Total length, 210; tail, 5.2; width of body, 12; width in length, 17.5 times; head length, 12; head width, 9; tail length in total length, about 40.4 times.

Variation: Another specimen, an adult topotypic paratype No. 35944 is almost an exact counterpart of the preceding specimen. It measures 220 mm. in length and the body width is contained in

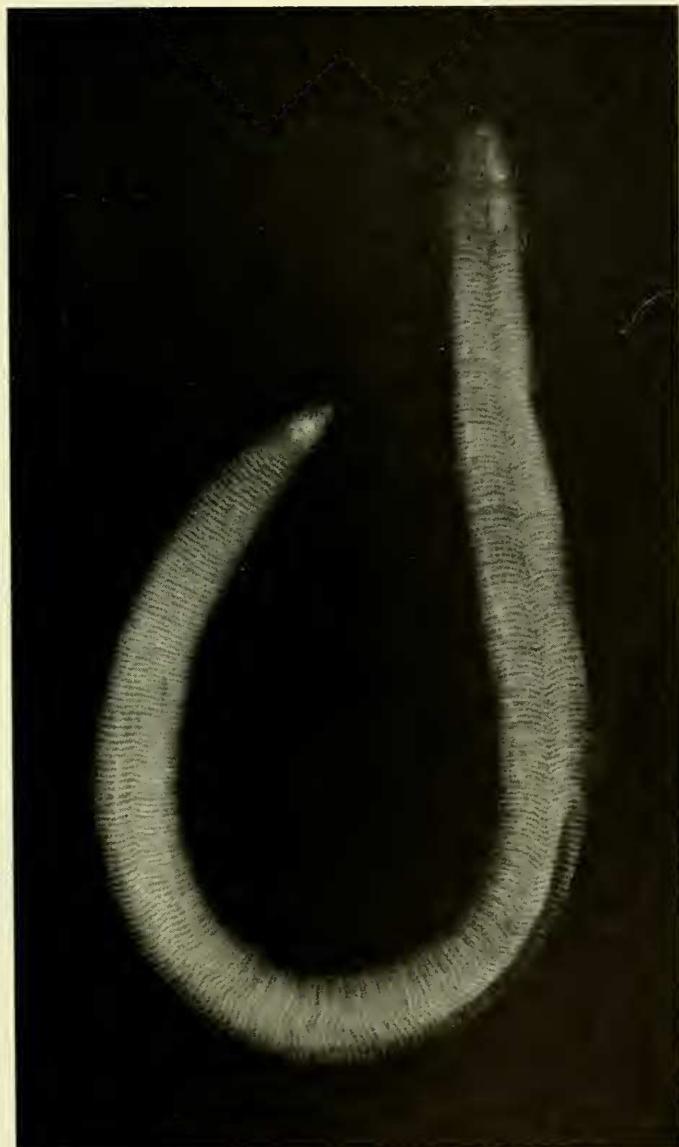


FIG. 24. *Ichthyophis youngorum* sp. nov. Type. E. H. T. No. 35946; ventral view. Actual length, 210 mm.

the length 18 times. The count of the transverse folds on the dorsum is 328, the lateral count, 292, the ventral count, 285; vertebrae 106.

The following table of data gives the size and other variations in a series of larva taken within a few meters of the adults. All are

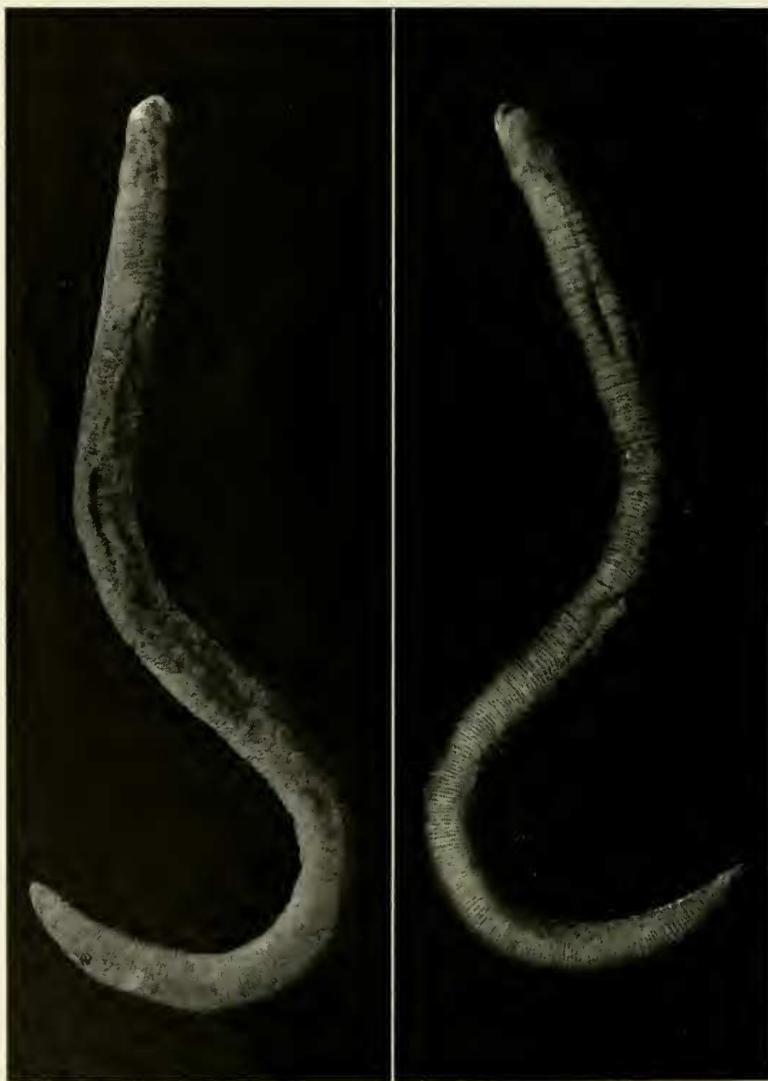


FIG. 25. *Ichthyophis youngorum* sp. nov. Paratype, larva; E. H. T. No. 35940. Topotype. Left figure, dorsal view; right figure, ventral view. Actual length, 217 mm.



FIG. 26. *Ichthyophis youngorum* sp. nov. Larval paratype E. H. T. No. 35940. Radiograph showing 107 vertebrae. Actual length 217 mm.

from a mountain rivulet, the larvae having been taken from under rocks, trash or gravel in the stream bed.

The larvae have a single gill opening (spiracle) on each side flanked by two small fleshy lobes. The neuromast system is present on the head of the youngest larvae.

The eye is represented in the larvae by a gray spot and only rarely can the outlines of the pupil and iris be discerned. In young larvae the tentacular opening has not appeared; in older ones a depression may be found in the eye spot, and in the still older ones there is a tentacular opening, usually curved, in the gray eye-spot. The caudal fin is low and even in the youngest it can scarcely be traced

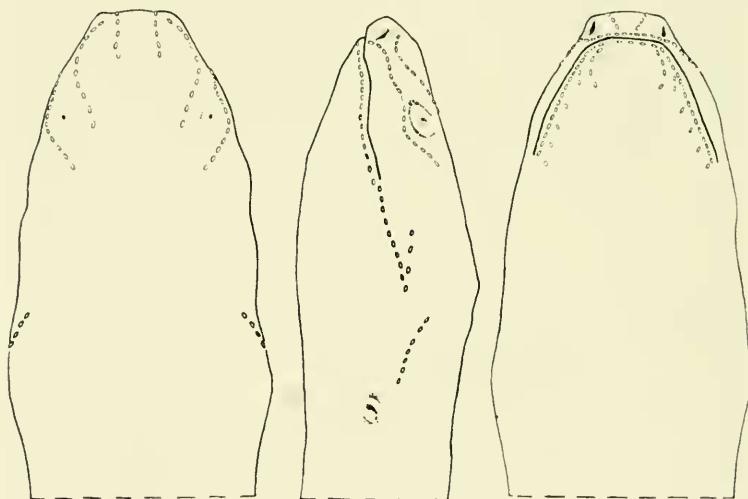


FIG. 27. *Ichthyophis youngorum* sp. nov. Larval paratype. E. H. T. No. 35949; topotype. Dorsal, lateral, and ventral views, showing the neuromast system of young larvae.

below the tail. In the older larvae the fin has completely disappeared. The young larvae are lighter in color than adults, while the older larvae may be a shade of ultramarine in color.

The largest larva 240 mm. has 106 vertebrae. Five larvae were X-rayed and the vertebrae were 106 or 107.

Specimens were kept alive for a time in shallow water. They were constantly moving when in the light. A slight noise could be heard when they were taken from the water, presumably caused by the water moving through the spiracle. No eggs were found.

This species is named for the family of Oliver Gordon Young of Chiang Mai, Thailand. Mr. Young has been untiring in his efforts to assist my work.

TABLE 2.—Data on *Ichthyophis youngorum* sp. nov.

NUMBER	Length	Width	Width in length	NUMBER	Length	Width	Width in length
35930....	75	5	15	35928....	119	6.3	18.8
35927....	80	5.2	16	35934....	127	7.5	16.9
35947....	80	5.2	16	35931....	142	8.7	16.4
35949....	81	5	16	35932....	147	9.2	16
35929....	84	5	17	35935....	162	9	18
35933....	85	5.2	16.4	35937....	184	10.2	18
35948....	86	5	17				

Number	Length	Width	Width in length	Dorsal count of folds	Ventral count	Max-premaxillary teeth	Vomeropalatine	Mandibular	Splenial
35936	194	11	17.6	325	280	14-14	18-18	18-18	12-12
35941	195	12	16.2	317	276	13-14	18-19	19-19	10-10
35942	213	12.5	17	314	302	16-16	16-18	19-19	10-10
35939	214	12.5	17.1	324	303	.....	.....	.....	.....
35938	214	12	18	320	284	14-14	16-17	19-19	9-9
35940	217	12.2	17.8	313	304	16-16	18-18	19-19	10-10
35943	217	12.2	17.7	316	283	16-16	19-19	19-20	10-10
35945	240	15	16	310	278	14-16	19-19	20-20	9-8

Ichthyophis sikkimensis * sp. nov.

Type: California Academy of Sciences, No. 64216, Darjeeling, India.

Paratypes: British Museum No. 87.11.2.28, Darjeeling, Bengal, India. Museum Comparative Zoology, No. 2685, Rungeet Valley, British Sikkim, Tom Barbour collector; Berlin Museum, No. 2574, Sikkim.

Diagnosis: A medium-sized species, characterized by 106-108 vertebrae; primary and secondary transverse folds 276-292; series of splenial teeth (9-9 or 10-10); tail very short, contained approximately 50 times in total length, bearing five or six folds from front of vent; tentacle near lip, closer to eye than to nostril. Seales sparse or absent in anterior half of body; two to four rows in each fold posteriorly.

* Sikkium + ensis (Latin) = place or country.

Description of type: A medium-sized species, largest known specimen, 276 mm. in total length; head slender, its width at first annular groove (10 mm.), less than length of head (11 mm.); eye closer to lip than nostril; tentacle very close to lip, nearer to eye (1.7 mm.) than to nostril (2.9 mm.); distance between eyes (6.1 mm.) greater than length of snout (5.2 mm.).

First annular groove distinct laterally, dim on throat, not completely crossing head; second groove crosses throat passing up on sides of head but a short distance; third groove distinct laterally not completely crossing neck either above or below; first two or

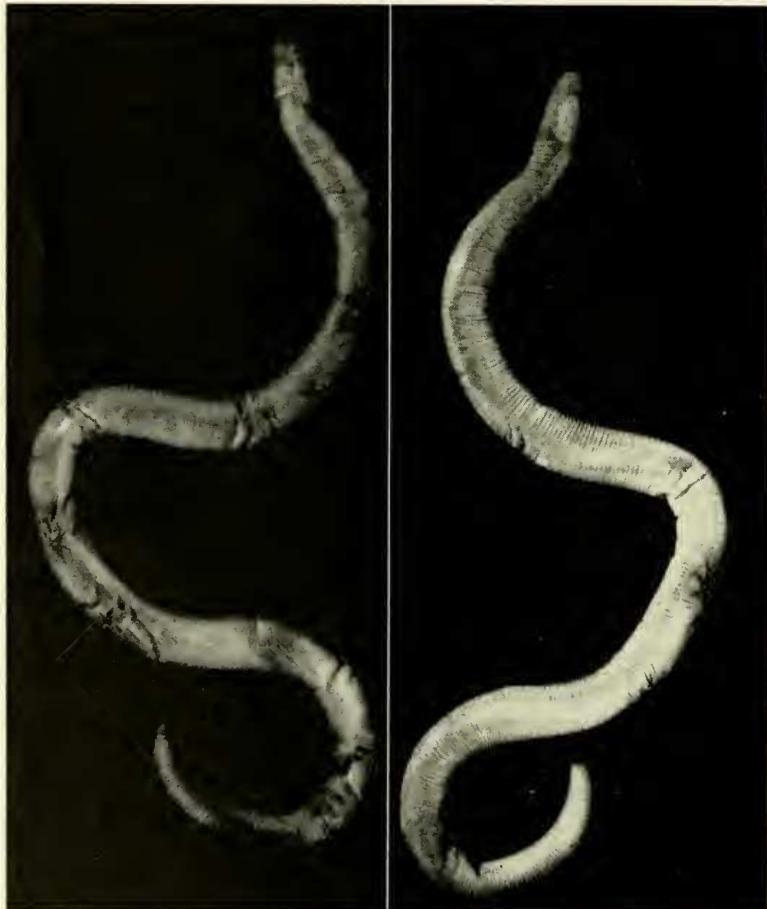


FIG. 28. *Ichthyophis sikkimensis* sp. nov. Paratype. Berlin Mus. No 3574. Left figure, dorsal view; right figure, ventral view. Actual length, 270 mm.

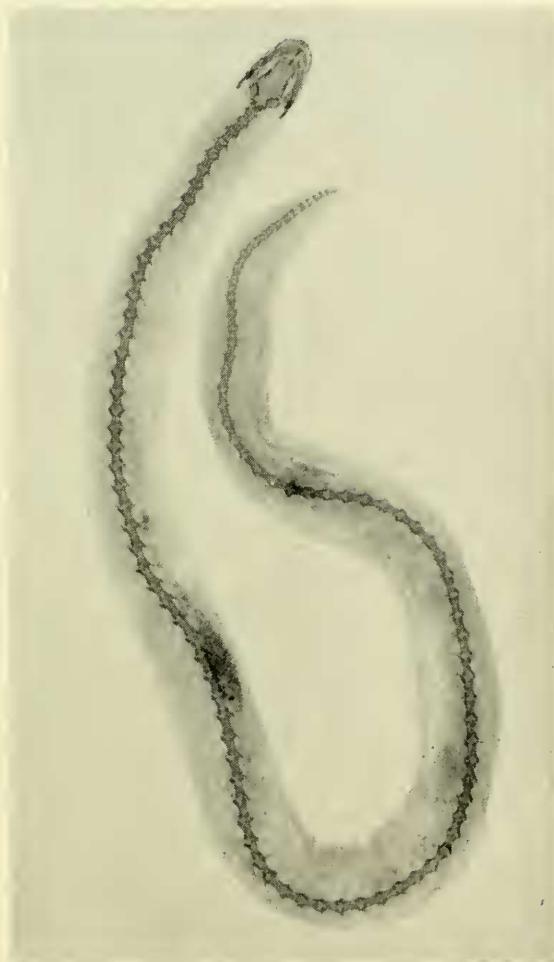


FIG. 29. *Ichthyophis sikkimensis* sp. nov. Paratype. B. M. N. H. No. 87.11.2.28. Radiograph showing 108 vertebrae.

three transverse folds not meeting below; primary and secondary folds forming a slight median ventral angle, the grooves not meeting on venter except posteriorly; (ordinarily, unless the specimen is somewhat dessicated the meeting of the folds on venter can be seen only dimly or not at all); total primary and secondary folds, 284, four of the posterior ones interrupted by vent; six folds on tail counting from front edge of vent; tail-tip rather conical; a slight longitudinal groove or depression on chin and throat.

Teeth: maxillary-premaxillary, 23-23; vomeropalatine, 21-21; mandibular, 20-21; splenial, 10-10.

A pair of small pimples (glands) on each side of vent.

Color: The specimen has been long preserved. The color is dark brown (a little lighter on the ventral surfaces). The underside of chin still lighter, while the grooves on chin and neck are marked dimly with cream; a more or less distinct cream tip on tail; a narrow cream ring about eye; a small cream spot about nostril and tentacle; the lips and tip of snout very light tan to cream.

Measurements in mm.: Total length, 276; tail, 5.5; width of body, 12.2; head width, 10; head length, 11.

Variation: No. 2685 has the pharyngeal region considerably thickened and widened. The eye is milky white, the pupil not visible. The tongue seemingly is not completely developed. It is very short covering the splenial teeth, and its posterior limit is a

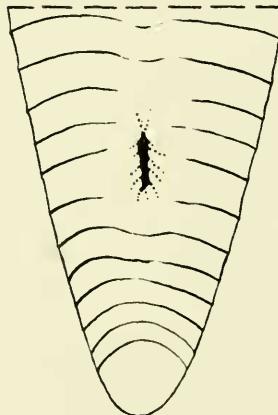


FIG. 30. *Ichthyophis sikkimensis* sp. nov. Type. Ventral view of caudal region. Enlarged.

ridge curving forward. This specimen agrees reasonably well with the others in tooth counts, vertebrae and transverse folds. It is, judging from the tongue, a recently transformed specimen that has not attained all the adult characters.

No. 3574, the other Sikkim specimen, is very light, almost white, on the venter and nearly white on chin. I cannot be certain that this specimen has not been faded somewhat by light.

The two Darjeeling specimens vary but little from each other.

Nothing is known of the exact habitats except that No. 2685 comes from the Rungeet Valley.

Data on type and paratype of Ichthyophis sikkimensis

NUMBER	Total length	Tail	Body width	Transverse folds	Vertebrae	Width in length	Maxpremaxillary	Vomeropalatine	Mandibular	Splenial
64216.....	276	5.5	12.2	284	.....	22.6	23-23	21-21	20-21	10-10
87.11.2.28	263	5.4	12	292	108	22	23-23	21-21	20-21	10-10
2685.....	271	4.5	10	282	106	27	23-23	20-20	21-21	9-9
3574.....	270	4.5	10	276	107	27	23-23	21-21	18-19	9-9

*Ichthyophis sumatranaus** sp. nov.

Type: U. S. Natural Museum No. 70672, Kapahiang, Sumatra; H. C. Kellars, collector.

Paratypes: U. S. N. M. Nos. 70667, 70669, Kaba Wetan, Sumatra; 70670, Kapahiang, Sumatra; all collected by H. C. Kellars.

Diagnosis: A medium-sized species characterized by an elongate series of splenial teeth, in adults 10-10 to 13-13; vertebrae, 110-112; transverse folds, females, 328-329; males, 315-318; tail in total length in larger adults about 54-57 times; body width in total length, average about 28 times; a semicircular row of small cream glandules partly surrounding eye; largest specimen, 285 mm. in length.

Description of type: Eye distinct, the lens appearing white, surrounded by a black iris; a small whitish spot in front of eye; a continuous semicircular row of tiny glandules run up from behind eye, then forward, terminating in the light mark in front of eye, (right eye abnormal); tentacle somewhat rounded at tip rather than conical, the tentacular opening lunate, curving above tentacle, opening close to lip at a point closer to eye (1.7 mm.) than to nostril (2.8 mm.); distance between eyes measured on a curve, 5.5 mm.; length of snout, 4.4 mm.; distance between nostril and eye, 4 mm.; tip of snout to first nuchal groove, 11.3 mm.; to second, 14.6; to third, 18.5; first groove not visible above, moderately distinct ventrally; second very distinct ventrally, slightly so on side of neck; third only indicated laterally.

* Sumatra + anus (Latin) = place, location, country.



FIG. 31. *Ichthyophis sumatranaus* sp. nov. Type. U. S. N. M. No. 70672.
Kapahiang, Sumatra. Actual length, 273 mm.

The first four or five transverse folds do not meet on venter; other folds cross back almost directly, curve back ventrally and form a median ventral angle, three to four millimeters behind the point where they crossed above; in the posterior part, the folds pass around body in about the same plane without forming an angle; vent interrupts five or six folds; total transverse folds, dorsal count, 315; 7 folds on tail; the transverse grooves rather dim (the specimen has been dehydrated slightly) and in places cannot be clearly discerned. They are distinct on sides and in the posterior part of body. The specimen is a male.

Small scales present anteriorly but sparse on dorsal and ventral parts of folds; more posteriorly they increase in size and number until there are three to five transverse imbricating rows passing around the body in each fold, partially overlapping the series of scales of the following fold, but separated from them by a row of recumbent glands lying nearly longitudinally.

Teeth: maxillary-premaxillary, 22-21; vomeropalatine, 22-21; mandibular, 20-19; splenial, 13-13. Vertebrae 112.

Color in preservative: Above dark brown, the grooves slightly lighter; ventral coloration a lighter shade of brown; a cream mark at vent, and at tip of tail; a tiny spot of white in front of eye and a fine semicircular row of cream-colored glandules partly surrounding eye; a cream spot at tentacle and nostril; edge of lips cream.

Measurements in mm.: Total length, 273; tail, 5; body width, 10; head length, 10.5; head width, 8.6.

Remarks: There are three paratypes, one a topotype from Kaphiang, a female, and two from Kaba Wetan.

No. 70667 the smallest specimen has had the internal organs removed. Where sex has been determined females have the higher count of transverse folds. The series is too small to postulate that this is generally true. This specimen has the eye-area milky white, the eye being distinguished with difficulty. In consequence the semicircular series of glandules cannot be seen. The specimen is violet-plumbeous in color. These seeming differences from the type may be due to age and method of preservation.

No. 70672 has the head somewhat lighter than body. The tip of the snout is somewhat cream-colored. This specimen shows a lighter line along the grooves, a character not or less evident in the smaller specimens.

The following table presents characters of these specimens.

Table of data from paratypes of *Ichthyophis sumatranaus*

NUMBER	Length	Tail	Body width	Width in length	Head width	Head length	
70669.....	285	5	9.5	30	9	11.5	
70672.....	273	5	10	27.3	8.6	10.5	
70667.....	205	3.5	8	25.5	7.2	10.1	
70670.....	176	3.2	6	30	6	9	
NUMBER	Verte-brae	Body folds	Tail folds	Max-pre-max.	Vomero-palatine	Mandibular	Splenial
70669.....	112	329	7	21-21	21-21	23-22	12-13
70672.....	112	315	7	22-21	22-21	20-19	13-13
70667.....	110	328	7	22-22	19-19	20-20	12-13
70670.....	110	318	7	20-21	24-23	18-19	10-10

*Ichthyophis acuminatus** sp. nov.

Type: American Museum of Natural History, No. 20875, Me Wang Valley, Thailand, Malcolm Smith, collector.

Paratypes: British Museum (Natural History), No. 1921.4.1.338, Me Wang, N. Thailand (field No. M. S. 3135); Malcolm Smith field Nos. 5656 Muang Liep, Thailand, and 3185, 3187 Pa Meang, Me Wang, Thailand.

Diagnosis: Large (about 300 mm.); head rather acuminate; eyes visible, very small; tentacle near lip, twice as close to eye as to nostril; splenial teeth, in transformed specimens, 15-15 to 22-22 in old adults; tail short, without cream spot about vent. Scales present in posterior part of body, wanting or greatly reduced anteriorly; body width in body length (in adults) about 20 times; transverse body folds on dorsum, 315-330, on venter, 297-320; vertebrae, 109-110. Larvae transform at a length of about 205 mm. Tail length in total length, approximately 43 times.

Description of type: Body thick, short, with dorsolateral ridges evident along sides; head acuminate, and, seen from above, forming a triangle; eye visible, minute (.7 mm.); tentacle close to lip,

* acuminatus (Latin) = pointed, referring to the snout.



FIG. 32. *Ichthyophis acuminatus* sp. nov. Type. A. M. N. H. No. 20875.
Me Wang Valley, Thailand. Actual length, 295 mm.

minute, conical, the opening somewhat horseshoe-shaped, closer to eye (1.7 mm.) than to nostril (3.8 mm.); width between eyes, 7.8 mm. (measured on curve); length of snout, 5.8 mm.; tip of snout extending beyond mouth, 1 mm.; width of head, 11.6 mm.; length of head, 14 mm.; first annular groove well defined on sides of head and under chin; second groove ventral, ascending on side of head slightly, separated from preceding groove by a distance of 4 mm.; third groove scarcely indicated; first primary fold does not cross throat; all subsequent primaries and secondaries practically complete ventrally; the anterior folds are dim or incomplete dorsally on anterior fifth or sixth of body; the folds slightly angled on venter, while elsewhere they pass nearly straight across body; 315 primary and secondary folds, counted dorsally; 303 counted on venter; six confined to tail. Tail length in total length approximately 43 times.

Scales present in posterior two thirds of body, one or two rows to each fold; if present anteriorly scales much reduced, not extending on to venter and usually the scales in each transverse row are not contiguous; vent longitudinal, interrupting six folds; tip of tail pointed, flat on ventral surface, somewhat compressed laterally.

Teeth: maxillary-premaxillary series, 24-25; vomeropalatine, 26-27; mandibular, 25-24; splenial, 22-22 much smaller than other teeth. Tongue rather pointed, not covering the large series of splenial teeth. Vertebrae, 110.

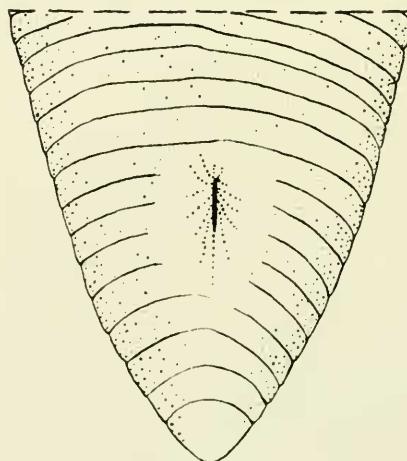


FIG. 33. *Ichthyophis acuminatus* sp. nov. Type. Ventral view of caudal region. Enlarged

Color in preservative: Somewhat violet-lavender, nearly uniform above, tending to be slightly lighter on throat and chin; area about vent somewhat lighter but not cream; area about tentacular opening cream; lips light flesh to cream.

Measurements in mm.: Total length, 295; tail, 7 (from front of vent); head width, 11.6; head length, 14; body width, 14.6; body width in length, 20.2 times.

Variation: There are two other transformed specimens from the Me Wang Valley in northern Thailand and a small series of larvae that most probably belong to this species. The larvae are listed with the adults in the following table, showing comparative measurements. The most significant variation (in teeth and folds) are given. The difference in count on dorsum and on venter is such that both counts are given. A lateral count is not likely to be either higher or lower than these counts. The counts of teeth and folds in the younger larvae are not trustworthy, hence are not recorded in the table.

Ichthyophis nigroflavus * sp. nov.

Type: U. S. N. M. No. 129462 "within 20 miles of Kuala Lumpur," Selangor, Malaya; Traub and Tipton collectors.

Diagnosis: A large species (425 mm.) the width contained in length about 26.5 times; body folds, dorsal count, 416 (ventral 399); folds on tail 7-8; vertebrae 123; maxillary teeth, 31-32; vomeropalatine 32-33; mandibular, 28-29; splenial, 0-0. Black above and below, a yellow lateral stripe beginning under eye narrow at first, widening posterior to pharynx; eye, tentacle and nostril with gray-white rings or spots (not cream).

Description of type: Head oval anteriorly, the sides nearly parallel, its width at first nuchal groove 10.7; head length, 12.8; eyes distinct, the lens white surrounded by a very narrow line of black (iris); these surrounded by a complete ring of gray-white; the distance between eyes, measured on the curve (8.5 mm.), greater than snout length (6 mm.); eye and nostril equidistant from lip, the distance between them, 4.9 mm.; tentacle conical the opening hump-shaped, situated closer to eye (1.5 mm.) than to the nostril (3.8 mm.); tip of snout extends beyond nostril 1 mm.; tip of snout to first nuchal groove, 14 mm.; to second, 18.2 mm.; to third, 22.2 mm.

Dorsal count of primary and secondary folds (they cannot be distinguished), 416; counted on venter, 399; folds on tail, 8; scales

* *nigro* (Latin) = black + *flavus* (Latin) = yellow

Table of variation in *I. acuminatus*

Age	Number	Body length	Body width	Width in length	Dorsal folds	Ventral folds	Verte-brae	Max-pre-max.	Vomeropatinate	Man-dibular	Splenial
Larva	3189	1.51	6.8	22	...	...	...	...	...	...	...
Larva	3188	1.52	8	19	...	...	...	...	...	...	...
Larva	3184	1.75	8.1	21.6	...	...	...	...	...	...	...
Larva	3796	1.71	7.9	22	...	...	...	...	...	...	...
Adult	1921.4.1.338	20.5	10	20.5	315	297	110	22-22	22-22	22-23	13-14
Adult	5656	20.5	9	23	332	320	109	24-24	24-24	25-25	15-15
Larva	5701	20.5	10	20.5	331	322	110	16-17	23-23	20-22	11-12
Type	20875	20.5	14.6	20	315	303	110	23-25	26-27	25-24	22-22

are absent or if present minute on anterior sixth of length; more posteriorly they increase in number and size and in the posterior part of the body there are four or five transverse overlapping imbricating rows in each fold. There are 123 vertebrae. First nuchal groove surrounds head; second not visible above; third distinct laterally but can be traced across throat.

There are no splenial teeth, but in the other series the number of teeth exceed any other form described from southeastern Asia and the archipelagoes.

Teeth: maxillary-premaxillary, 31-32; vomeropalatine, 32-33; mandibular, 28-29; splenial, 0-0.

There are two small glands present on each side of the vent in its anterior part; the vent interrupts three folds; the length of the tail in total length, approximately 70 times.

Color in fixative: Dorsum and venter black with a cream lateral stripe, the edges of which are very irregular. Anteriorly it begins under eye, passes back to neck where it widens and continues to level of vent narrowing posteriorly; a small cream spot at vent, at tentacle and nostril; ring about eye gray-white; chin and throat deep black. There are many minute black flecks on the cream stripe.

Measurements in mm.: Total length, 425; tail, 6; width of body, 16; width of head, 10.7; length of head, 14.

Remarks: The specimen has been somewhat dehydrated and in such places the black has become olive, and the ventral black shows a whitish surface.

Another specimen U. S. N. M. No. 129463 bears a similar label but this is unquestionably a different species. It differs among other characters in having approximately 100 less folds and there is a series of splenial teeth present.

The characters of the black color, the large number of vertebrae (123), the large number of folds, and absent splenials set this species apart from other Asiatic forms with a lateral stripe.

*Ichthyophis paucisulcus** sp. nov.

Type: U. S. National Museum No. 103565; from Siantar, Sumatra; National Geographical-Smithsonian Institution Expedition, coll.

Diagnosis: A short, broad species the width in length about 17 times; transverse folds on body, 259 dorsal count, 263 lateral count, folds on tail, 5-6; tail length in total length, approximately 54 times;

* *pauci* (Latin) = few + *sulcus* (Latin) = groove.

splenial teeth 14-14; choanae oval (not angular); grooves not meeting on venter except in posterior part of body; folds forming a very obtuse angle on median ventral line except posteriorly where the grooves and folds go straight across venter. A narrow cream lateral stripe, not broken on neck.

Description of type: Head nearly as broad (11.2 mm.) as long (12.6 mm.); eye-spot elevated, circular, showing a darker center and a ring of cream; tentacular opening lunate, situated near lip, distinctly closer to eye (1.6 mm.) than to nostril (3.7 mm.); distance between eyes (7.4 mm. measured on curve) much greater



FIG. 34. *Ichthyophis paucisulcus* sp. nov. Type. U. S. N. M. No. 103565, Siantar, Sumatra. Actual length, 256 mm.

than snout length (5.2 mm.); nostril 1.2 mm. distant from lip; eye, 1.8 mm. from same; eye from nostril, 4.7 mm.

Snout to first nuchal groove, 13 mm., to second, 16.8 mm., to third, 20.2 mm. (the measurements made on side of head); first groove distinct, passing entirely around head; second distinct below and on sides to level of mouth; third distinct laterally, absent on throat, dimly indicated above; folds forming an obtuse angle on venter except posteriorly where they are straight; grooves cannot be traced across venter in anterior half of body; folds, dorsal count, 259; lateral count, 266. A few of the folds split on the side; vent longitudinal, interrupting four folds. A pair of slight swellings on each side of vent suggest the presence of special glands; 5 or 6 folds on tail from front of vent; small scales are present on dorsum on anterior part of body but do not pass to ventral side; posteriorly the scales increase in number of rows in each fold and they are continuous around body, as many as four or five rows present posteriorly.

Teeth: maxillary-premaxillary series, 28-28; vomeropalatine, 26-27; mandibular, 28-28 the posterior teeth very small; splenial, 14-14. The tongue (injured) has a triangular thickened anterior part that probably covers the splenial tooth series; the remainder of the tongue is thinner and striated.

Color in preservative: Above lavender-slate; a longitudinal cream stripe beginning as a narrow line below eye, passes back laterally and is interrupted at the third costal groove; the stripe widens and terminates laterally at level of vent, the edges of stripe not discrete; entire venter with rather indistinct very numerous markings of lavender and tan, not strongly contrasting, placed transversely; a well-defined cream spot surrounds vent; a cream spot at tentacle; tip of snout light; the lower lips cream, the jaws grayish below with a grayish spot on chin. The stripe does not bifurcate at angle of the mouth.

Measurements in mm.: Total length, 256; tail, 4.7; body width average about, 15; width in length about 17 times; head width, 11.2; head length, 12.6; tail length in total length approximately 55 times.

Remarks: A specimen obtained by W. L. Abbot on North Pagi Island in the southeastern part of the Mentawai group may belong subspecifically with the preceding species. It differs in having teeth and bones green, a condition most probably caused by some accident of preservation. The characters of this specimen show some significant variation. It is slenderer proportionally, the head longer,



FIG. 35. *Ichthyophis paucisulcus* sp. nov. A specimen U. S. N. M. No. 31701 from Pagi I, Mentawai Group, Sumatra, referred to this species. Actual length, 210 mm.

slightly fewer body folds (9). The vertebrae number 104. The lateral light stripe is narrow and indistinct.

Total length, 201; tail, 4; tail in length, 50 times; body width, average, 10; width in length, 20 times; head width, 9; head length, 12.4; tip of snout to first groove, 9.6; to second groove, 12.6; to third, 15.2; total folds on body, 250; folds on tail, 8. Teeth: Maxillary-premaxillary series, 22-20; vomeropalatine, 22-22; mandibular, 22-23; splenial, 10-10. Tongue somewhat pointed, not covering splenial teeth.

Ichthyophis supachaii sp. nov.

Type: EHT-HMS No. 35498, 10 km. west Nakon Si Thamarrat, Nakon Si Thamarrat province, taken Apr. 30, 1958 by E. H. Taylor.

Paratypes: EHT-HMS Nos. 35497, 35499. Topotypes same date and collector. No. 34677 young, transformed 18 km. N. E. Betong, Yala, Nos. 35781-82 larvae and one transformed young, No. 35780 Kao Chao Forest Station near Trang, Trang Prov., Nos. 35594-96 larvae and No. 35593 young transformed specimen, Rompibong Tin Mine, Nakon Si Thammarat.

Diagnosis: A relatively slender, elongate species, the largest specimen known, 306 mm., with a lateral cream stripe broken on neck; numerous scattered cream spots on dorsum and venter; width in length, 30.6; tail in length 102 times; mandibular teeth reduced in number, the splenials 18-18 becoming more prominent; folds 322; larvae transform at small size (before a length of 125 mm. is reached); tentacle nearer to eye than to nostril.

Description of type: Head rather flattened, its greatest elevation, 3.2 mm.; width of head (9.2 mm.) less than the length (13 mm.); distance between eyes (6.2 mm.) greater than length of snout in front of eyes (5 mm.); tentacle conical, the opening somewhat lunate, closer to eye (1.8 mm.) than to nostril, 3.5 mm.; distance between eye and nostril, 4.8 mm.; tip of snout to first nuchal groove, 12.2 mm.; to second, 16.4 mm.; to third, 20 mm.

Primary and secondary folds, 322, with 4-5 on tail; the grooves failing to meet dorsally or ventrally anteriorly; scales absent in anteriormost folds, appearing first dorsally where they are in a single row in each fold, and about one-half millimeter in diameter; posteriorly they are both dorsal and ventral, surrounding body, in from three to five rows in each fold, overlapping transversely.

Teeth: maxillary-premaxillary, 31-32; vomeropalatine, 27-27; mandibular, 8-6; splenial, 18-18. Tongue oval, rather narrowed anteriorly, not covering, in fact not reaching, the splenial teeth.

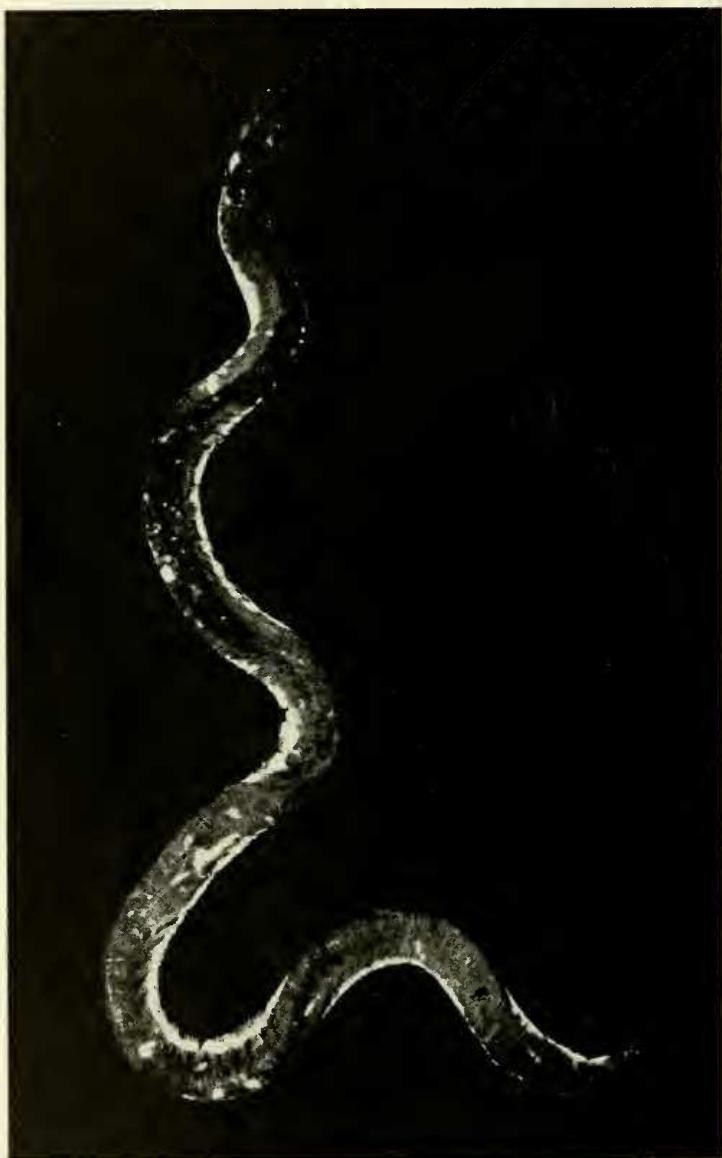


FIG. 36. *Ichthyophis supachaii* sp. nov. Type. E. H. T. No. 35498, 10 km. W Nakon Si Thammarat, Thailand. Actual length, 306 mm.

Color in life: Above dark plumbeous lavender; gray slate below; a spot of cream near mouth angle; another spot on side of pharynx; a cream lateral stripe begins at the third nuchal groove and continues to a point somewhat in advance of the vent; numerous flecks and spots of cream on venter, a few present on dorsum. Eye with a pearly lens surrounded by a fine ring of black, and a narrow, incomplete ring of cream about eye, a cream spot about tentacle and one about vent; extreme tip of tail light; a small median cream spot on occiput.

Measurements in mm.: Total length, 306; tail length, 3; width of body, approximately, 10; width in length, 30.6 times; tail in length, 102 times; width of head, 9.2; length of head, 13.

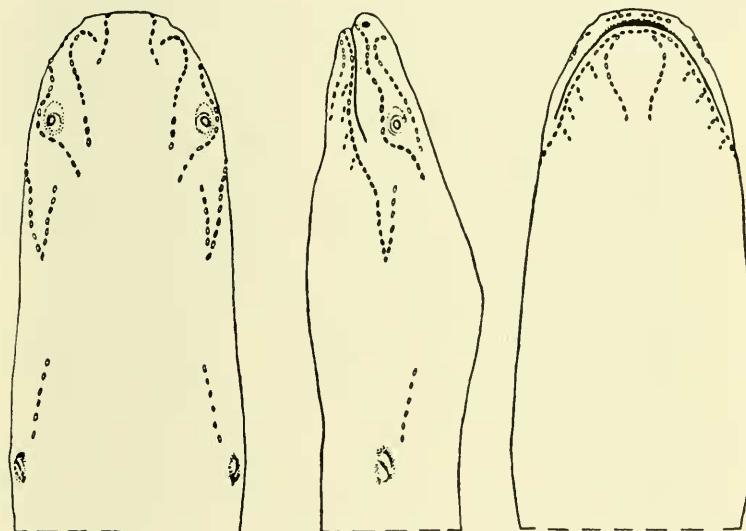


FIG. 37. *Ichthyophis supachaii* sp. nov. Paratype larva, E. H. T. No. 35781, near Trang, Trang Prov., Thailand. Actual length, 97 mm.

Remarks: Two small specimens, one recently transformed, were taken with the type in clay soil on the bank of a small stream. It would appear that the species completes its transformation when it is less than 125 mm. in length.

Measurements of EHT-HMS No. 35499 topotype: This is the smallest of the two topotypes and has the following characters: Total length is 125 mm.; the tail, 2.8 mm. (a portion of the caudal fin is still evident in a compressed ridge that extends along the dorsal surface of the tail reaching the tail tip). The width of the body is about 5 mm., the width of head, 4 mm., the length, 7 mm.

The transverse folds number 313, seven being confined to the tail. The folds meet in an obtuse angle ventrally as they do in the type.

The teeth foreshadow the condition obtaining in the adult but all the series are reduced. I count only five maxillary-premaxillary teeth on each side. In the vomerine series there are seven on each side. In the mandibular series I find a pair of very tiny teeth near the symphysis, then three widely spaced enlarged teeth. In the posterior part of jaw there is a single tooth visible on one side, two on the other. The splenial series has two enlarged anterior teeth (as large as the mandibular), followed by three symmetrically spaced teeth on each side. The tongue lies completely behind the splenial row, and is poorly developed at this stage.

The young larval specimens do not show the white spotting on dorsum or venter. There is a small cream mark running from the eye (which is distinct) to the tentacle. The gill opening is single.

The characteristics of the mandibular teeth distinguishes this species from all others here recognized.

The species is named to honor Prof. Supachai Vanijadhana, Secretary General of Chulalongkorn University, whose interest in the faunas of Thailand made possible my journeys in that country.

Ichthyophis kohtaoensis sp. nov.

Type: U. S. National Museum No. 72293, Koh Tao Island, west side, Gulf of Siam, Malcolm Smith collector, (field number 2932).

Paratype: U. S. National Museum No. 76138, topotype, same collector.

Diagnosis: A form with lateral stripes; a large series of splenial teeth (17-18); number of transverse folds, lateral count, 362-366; tentacle small, opening near lip, closer to eye than to nostril; eye very distinct; light stripe widens on side of head and bifurcates at mouth, terminating anteriorly below eye; posteriorly, somewhat in advance of level of vent; width in length about 24 times; known length, 280 mm.

Description of type: Head rather narrow, the pharyngeal region a little wider than head; width of head at first groove, 8.7 mm.; length of head, 12.1; width between eyes, 5.8 mm.; length of snout, 4.4 mm.; tentacular opening curved, small, near edge of lip, closer to eye (1.7 mm.) than to nostril (3 mm.). Eye distinct, the lens light surrounded by a narrow black rim, the eye itself surrounded by a narrow cream ring. First nuchal groove on neck, distinct on

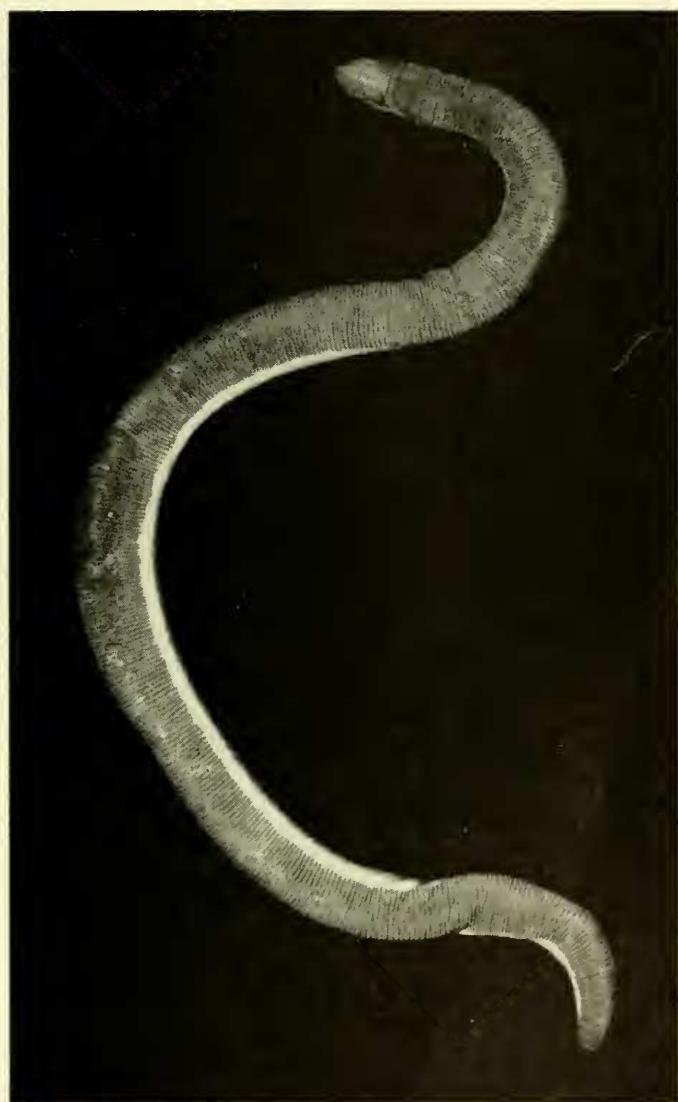


FIG. 38. *Ichthyophis kohtaoensis* sp. nov. Type. U. S. N. M. No. 72293, Koh Tao Island, west side, Gulf of Siam. Actual length, 280 mm.

sides and below; second groove strong below, reaching above the lateral light line; third groove can be traced around neck except on the median ventral point; three dorsal folds lie between the second and third nuchal grooves; the subsequent folds turn back somewhat on venter and meet on midventral line at an angle; the grooves fail

to cross the ventral surface except posteriorly in front of vent where the folds and grooves cross the venter in a straight line; longitudinal vent interrupts about four folds. Total transverse folds (dorsolateral count including the three dorsal) 362 of which six are confined to the tail; tail narrowing suddenly to a point, the subcaudal region flattened.

Scales present anteriorly (seemingly none on the three pharyngeal folds); at first an occasional small scale is present; more posteriorly scales increase in size and in number and two to three (perhaps four) rows of imbricating scales varying in size, are present in each fold the rows overlapping and extending around the body.

Teeth: maxillary-premaxillary, 22-23; vomeropalatine, 22-23; mandibular, 21-20; splenial, 17-18. Vomeropalatine teeth scarcely extending through gums.

Color in preservative: Generally lavender brown, the grooves lighter giving an effect of minute bands of light and dark; a broad lateral stripe of cream from eye to a point a little in advance of level of vent; a cream area about vent; venter same shade as dorsum; the lateral stripe widens behind mouth angle and bifurcates, the lower branch short, quickly becoming brownish; a small cream ring about eye; a cream area around tentacular opening, and one around nostril; lips and tip of snout light brown to brownish cream.

Measurements of type and paratype in mm.: Snout to vent, 280; 192; tail, 4.2; 3.3; width of head, 8.7; 6.9; length of head, 12.1; 9.6; width of body, 12.2; 8.2; width in length (times), 23; 23.4; tail length in total length (times), 66.6; 60.

Remarks: The paratype has a pair of triangular yellow cream spots on each side and slightly behind vent, of a shade lighter than the spot about vent. There are 366 folds (dorsolateral count). The teeth are: maxillary-premaxillary, 21-22; vomeropalatine, 16-17; mandibular, 19-19; splenial, 13-14. These specimens are from Koh Tao, a small island some 70 km. off the eastern shore of peninsular Thailand.

They differ from the mainland form chiefly in having a larger number of transverse folds on the body. The largest count made for specimens from the mainland of Thailand nearest these islands is 323 a difference of about 39 folds. Farther to the northeast in specimens from Viet Nam my highest count was 344.

The island of Koh Tao would appear to have had a somewhat different history from many of the islands in the Gulf of Siam. A number of its forms of reptiles and amphibians differ so much from

the mainland species that they have been recognized by species or subspecies names. As yet the island is little explored. The species is named from the island + ensis (Latin) place, country.

Ichthyophis beddomei Peters

Ichthyophis Beddomii Peters, Monats. K. Akad. Wiss. (Sitz. phys.-math. Classe), Nov. 1879, p. 932, pl. fig. 4 (type locality Nilgherries, India).

Diagnosis: A species having 240 transverse folds; the tentacular opening almost equidistant from eye and nostril; snout more pointed than in *glutinosa*; splenial teeth well developed; length, 225.

Description: "Nur 240 Hautfalten. Die Tentacle-grube kaum weiter von dem Nasloch als von dem Auge entfernt. Schnause spitzer als bie der vorhergehenden Art. Wie bei der vorigen an jeder Seite eine gelbe Längsbinde. Zweite Reihe der Unterkieferzähne wohl entwickelt. Totallänge 0,225; Kopf 0,011; Körperbreite in der Mitte 0,010.

"Von den Nilgherries. Wir verdanken diese Art der Güte des Hrn. Colonel Beddome. (M. B. No. 5545)."

It seems almost certain that this species is one distinct from *glutinosa* differing in having a hundred less transverse folds than the Linnean species.

This species was synonymized by Boulenger but an examination of the material that he studied now remaining in the British Museum shows that he has confused two or more forms.

Ichthyophis tricolor Annandale

Ichthyophis glutinosa tricolor Annandale, Rec. Ind. Mus., vol. 3, 1909, p. 286 (type locality, Maddathorai, India); *idem.*, vol. 9, pt. 4, no. 19, Aug. 1915, pp. 346-347 (Western Ghats, Cochin).

Diagnosis: A species having a white venter.

Description: Annandale describes the form very briefly as follows: "A specimen was taken at Maddathorai in a hollow tree. It had the whole of the ventral surface pure white, and therefore different in appearance from the typical form. A careful comparison, however with normal specimens, including a microscopic examination of the scales, reveals no other difference. I propose to call the form with the white ventral surface,—var *tricolor*."

Remarks: Annandale in 1915 reported two more specimens as follows: "Two specimens of this variety or local race were found by Mr. F. H. Gravely on the eastern slopes of the Western Ghats in Cochin in September last, the exact locality being Parambikulam (alt. 1700-3200 feet). The specimens are considerably larger than

the type, one of them being 280 mm. long. The yellow lateral band on each side is separated from the white median ventral band by a dark one, which is greyish in spirit. This dark band varies considerably in breadth."

The striking difference in coloration strongly suggests that we are dealing with a distinct species rather than a color variety since there are at least three other species of the genus occurring in the same general locality. The color pattern is normally very constant in caecilians. Since Mr. Annandale did not report on folds, teeth, vertebrae, and other significant characters, complete description must await re-examination of the type. Moreover we do not know what species Annandale used for comparison.

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